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THE

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THE LEGAL ASPECT OF THE SMOKE NUISANCE.

Engineering has collected a set of examples from legal decisions on smoke. In Crump *v.* Lambert, the plaintiff bought two leasehold houses in Walsall, and soon after, the defendant began to erect works, from which smoke was emitted by a 50 feet chimney. Judgment was entered for the plaintiff. In Rich *v.* Basterfield, the defendant had erected a chimney and works and leased them to others. He was not held responsible. In 1821 an Act was passed with a view to abating the wrong construction and negligent working of furnaces. Again in 1845, the Railway Clauses Consolidation Act provides that locomotives shall be constructed on the principle of smokelessness. Thus a locomotive may emit smoke, but must be so constructed as to be capable of not doing so; and in Smith *v.* the Midland Railway Company, the company claimed they were within their statutory powers in emitting smoke, &c., from their cleaning shed, but it was decided that the statute had not deprived the plaintiff of his ordinary rights, and he gained an injunction to restrain the company against so using their land. But in the Hammersmith Railway Company *v.* Brand, it was decided that in the majority of cases compensation can only be obtained from damages caused during and by the construction of a railway, not in respect of noise, smoke or vibration occasioned by its working.

In the Towns Improvement Clauses Act of 1847, Section 108 provided for proper construction of furnaces. In London the Public Health Act of 1891, which repealed two previous Acts of 1853 and 1855, had clauses bearing on smoke. Outside London the Public Health Act of 1875 applied to the whole of England. In 1878 the traction engine was ordered to be smokeless. As regards London, the 1891 Act demands proof of the owner's negligence, he not being liable for a servant's negligence. Thus, in Chisholm *v.* Doulton, in 1889, it was shown that the furnaces had been properly constructed, and the issue of smoke for 10 minutes arose from the act of a stoker in lighting up. Section 24 of the London Act, which is identical with Section 91 of the General Act of 1875, is the most important, providing that a furnace shall consume its smoke as far as practicable, and that no nuisance shall be held if the Court is satisfied that the construction is, as far as practicable, of the proper kind, having regard to the nature of the trade. As a fact, the Act is much more mild than its enforcement has of late proved to be. Our contemporary is inclined to welcome Sir William Richmond's new society. For ourselves we are not. We object to smoke as much as anyone, and would have all furnaces constructed as far as possible smokelessly. But we do not approve of the way in which the smoke nuisance is dealt with. We object to the class of men who, as a rule, are smoke inspectors. They have not the necessary technical knowledge to know when to strike nor when to cease striking, and smoke prosecution is very

apt to become persecution. As regards domestic fires, it is obvious there can be little done. It is an expensive matter to feed a domestic hearth from below. Many contrivances have been introduced to do this. Some of these are only applicable when a fuel of a certain size can be used, and people would not pay for either the fireplace or the fuel. The best we ever saw had a deep hopper full of coal, and this was fed up by rack and gearing, the green coal being the bottom of the fire. But it was necessarily expensive. But it is the domestic hearth which is the greatest smoke producer. It produces green gas, not black smoke, and loads the air with tar. The black smoke of a factory is trivial in comparison. We do not doubt that much of the present trouble in London has arisen because of the neglect of furnace construction due to the use of Welsh coal. When North country coal is used, the common furnace of course is shown up. But all the same, the owners of these furnaces cannot change them in a day. We are surprised that something has not been done by the North country coal owners, such as they did at the Keyham trials and at Wigan some years ago. It was then shown that these coals could be burned smokelessly, and had as good an evaporation as Welsh, and they were put on the Admiralty List. But the slight extra trouble involved seems so have put things back where they were before, and there is still a prejudice against bituminous coals, and always will be, no doubt, so long as any better skill is demanded in design or in firing. But it is always the bituminous coal which is used in the domestic hearth where it is least suitable. In proper furnaces it can be burned smokelessly for steam purposes. We should like to know if Sir W. Richmond uses Welsh or bituminous, or if he really does not know that it is the domestic fireplace which makes most of our smoke.

Professors as Consulting Engineers.—A correspondent of the *Engineer* finds great fault with the habits of professors who practise as consulting engineers. What he says is, that expensively equipped college laboratories are used by these professors as though they were their own particular property, and to the furtherance of their own private ends. He might have added that the students are similarly exploited as assistants to the professor in his highly paid private work. In a word, the professor advertises himself through his chair, and climbs into a lucrative practice at the expense of college students and parents, where other consultants have to pay office rent, purchase instruments, pay skilled assistants, and generally fight their way. Whereas the professor of a well-paid chair should really give to the public the knowledge he is able to acquire by means of publicly supplied equipment; he keeps the best of this to himself. In short, the professor is paid for one thing and does another, and so it comes that students speak of a professor wasting a lot of his time in the college. The college becomes his secondary consideration, and when fees grow big and equipment can be purchased, the professor is on his legs, and can afford to kick away the ladder up which he climbed. Now this is wrong. We are spending thousands on colleges, and the professorial element who place the poundal and pedagogic terminology above common sense are pulling the wires too much. What is wanted to-day are a few of the old school of professors, who placed their honour and their chair above the dictates of rank and fortune. A chair should be well endowed, and no outside practice should be allowed to interfere with its purity. If this sort of thing goes on, why should we not have the chair filled by some member of a manufacturing concern? He could so well advertise his own pet engine or boiler.

Tests of a Boston Tramway Power House.—A very elaborate test, extending over 45 hours, is reported in the *Street Railway Review* as having been made on the Harvard power station. This is the latest station of the Boston Elevated Railway Company, and is located near the Charles River, in Harvard Square. In plan the buildings measure 171 feet long × 125 feet wide, with a possibility of an addition of 71 feet to the length. There are six water-tube boilers of 3,000 total I.H.P. in a room 171 feet × 56 feet. They are 22 feet in length, and have each three 42-inch water drums, and carry 175 lbs. The flue contains a Green's economiser of 560 tubes, and delivers to a chimney 226 feet high and 11 feet internal diameter. There are thus nearly 6 H.P. to each tube of the economiser. The weak point of the water-tube boiler has been provided for by extending the furnaces in front of the boiler, and thus providing more space for combustion, and the proper arrangement of the fires and gases, a necessity where bituminous coal is intended. There are three main engines of cross compound type with cylinders 28 inches and 56 inches × 60 inches, and of nominally 1,800 H.P. each, with 60-ton flywheels 24 feet diameter. A receiver is interposed between the two cylinders, and a feed heater between the L.P. cylinder, and the condenser serves to warm the water from the city mains before it enters the economiser. The injection water is drawn 300 feet from the river in a 20-inch pipe. Each engine drives directly a 12-pole 1,200-kw. generator at 80 r.p.m., whose normal output is 2,180 amperes at 550 volts. Suitable precautions were taken to ensure accuracy. These it is not necessary to detail. Four boilers were used, each with 5,340 square feet of heating surface and 84 square feet of grate surface. The average absolute pressure was 168·4 lbs, the steam showing a dryness factor of ·989. Coal was burned at the very moderate rate of 10·42 lbs. per square foot, and evaporated (including economiser) from and at 212°, 10·68 lbs. water. The feed entered the economiser at 126·86° from the condenser coil. It left the economiser at 209·3°, showing 7·62 per cent. of the total heat to be there acquired. Of the total feed supply about one half of 1 per cent. came from the separators. The total I.H.P. on the 45 hours test varied from 2,350 to 2,536, the best result being when 14·05 lbs. of steam per I.H.P. hour were consumed. About 90° of temperature was added to the originally cold feed by the exhaust steam. The hot gases entered the economiser at 460° and left at 254°. The electrical output was about 90 per cent. of the I.H.P. The power consumed by the feed pumps was about 0·7 per cent. They were run electrically. At no time did the coal consumption reach 1¾ lbs. per E.H.P.-hour, while it averaged about 1½ lbs. per I.H.P.-hour. The figures of the test are somewhat voluminous. They are interesting as showing the results in the latest and best practice in American traction work.

Flat Surfaces in Steam Boilers.—Especially in locomotives must there be flat surfaces exposed to steam pressure. Despite all that can be said as to heat transmission being theoretically as good through thick as through thin plates, there appears to be some cause for the better behaviour of thin plates in locomotive fireboxes. With flat plates and stay bolts there is constant trouble with leaking and broken stays and cracked sheets. It is proposed by a Chicago foreman to cup the sheets between the stays, whereby it is expected to prevent these troubles. In a flat sheet the surfaces between the stays tend to form so many depressions, and there is a tendency to crack at the stays. If already cupped this tendency is checked and the bending action across the stay bolt is avoided. The idea has every appearance of being sound, and in these days of hydraulic pressing it should be a simple matter to manufacture such cupped plates in a single stroke of a press. Hitherto with flat surfaces an increase of pressure has demanded larger stays more closely pitched or in thicker plates. The space between the stays has acted as a girder, and a straight girder carrying a load necessarily becomes cambered. Hence in cracking, strains which are to some extent really intensified by increase of plate thickness. Closer staying introduces undesirable elements. The cupped plate seems better calculated to transfer the load of pressure directly to the stays with less punishment of the plates.

THE HORSFALL DESTRUCTOR.

We have received from the Horsfall Furnace Syndicate a copy of reports by Lord Kelvin and Prof. Barr upon the Horsfall destructors at Edinburgh, Bradford, and Oldham. From the annexed illustrations it will be seen that the Horsfall refuse destructor, in either its single or double form, consists of a cell of brickwork, with a grate at one end and a raking door, and at the other end a chamber into which the refuse is fed at another door, and in which it is dried somewhat by the heat of the fire before being raked forward upon the grate. The principle on which a destructor is designed is that, while carbon will evaporate about 15 lbs. of water, it naturally follows that, theoretically, any rubbish containing at least one-fifteenth its weight of carbon, will supply heat sufficient to dry itself.

Taking the town of Oldham, the average value of the refuse is about one-seventh that of coal. In other words, a pound of refuse contains carbon sufficient to evaporate about 2 lbs. of water. Obviously, in 1 lb. of refuse there cannot be even 1 lb. of water, and it follows that refuse can therefore not only dry itself, but provide a further supply of heat sufficient to raise all the products of combustion to a high temperature. In destroying refuse the problem is to so conserve the heat generated, as to make it available for raising all vapours which are given off the green refuse to a high temperature. At one time boilers were set right above the grate of a destructor, and naturally the boiler effectually prevented anything approaching a temperature of destruction. In the Horsfall, as in any successful destructor, all combustion is completed in brick chambers or flues, and only when combustion is complete, and the products of all of a set of cells have been mixed, so that no cell can give off green vapours except these are mixed with the products of more brightly burning cells, are the hot gases allowed to give up any heat for steam raising purposes. This is at it should be. There is no harm done in utilising the heat, but no attempt ought to be made to do this prior to perfect destruction.

Utilisation of the heat is indeed recommended in the report, wherein it is stated that an evaporation of $1\frac{1}{3}$ lbs. of water should be easily possible at Oldham, and even $1\frac{1}{2}$ might be attempted with suitable arrangements, a rate corresponding to an efficiency of about 67 per cent.

The distilled vapours thus pass forward above the hottest part of the furnace, where dried material is burning under forced draught, the intensity of which is found to be best at 1 inch of water.

Steam is used as the draught producer, and is stated to keep the bars cool and to aid in the production of a water gas, which burns in the space above the fire by means of the additional air it meets there, and gives back the heat absorbed from the fuel on the grate. Seeing that the mean temperature of combustion of refuse is sufficient to maintain brickwork at a bright red heat, it follows that in any destructor the flues of which are carefully protected and air-tight, combustion will be perfect if the length of flue is sufficient and excess of air is not admitted. In destructor design this end is sought by employing flues of reasonably short length, whereby the same end is gained at a minimum structural cost. As the report states, moderate draught has been found best for more than one reason. Dust is less likely to be blown away at the chimney to produce a public nuisance. We have recommended the principle of the stive chamber as one means of overcoming the dust difficulty. At Edinburgh a dust collector has been formed by means of a circular chamber, 16 feet diameter, round which the gases are caused to travel, depositing their dust centrifugally, and escaping inwards to a central flue. In one week this chamber collected 53 cubic feet of dust. The sides of the furnace are made up of cast-iron air boxes, which serve a double purpose of preventing the adherence of clinker to the furnace sides, which formerly caused rapid destruction of the bricks, and of heating the blast. These air boxes seem to be very effective.

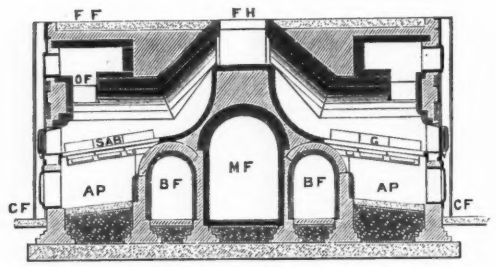
The labour cost at Bradford works out at 6d. per ton of refuse—at Oldham it is 9d. The report is emphatic that no smoke was produced, and that destruction was complete,

Horsfall Destructor at Oldham.

and that the furnaces can safely be placed in a populous district, so saving the cartage of refuse to long distances.

As a test of temperature at Edinburgh, metal discs showed over 1,100° and below 1,800° in the dust collector.

At Bradford a destructor of 12 cells deals with 650 tons per week, or, say, 10 tons per cell per day, and a thermo-



F F, Feeding floor; F H, Feeding hole; O F, Outlet flue; S A B, Side air box G, Grate; A P, Ash pit; C F, Clinkering floor; B F, Blast flue; M F, Main flue.

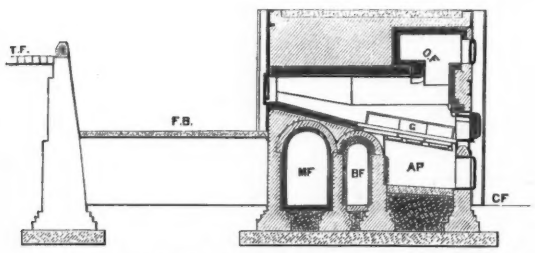
Horsfall Furnace—Back to back.

electric pyrometer recorded a temperature of 1,550° in the main flue; while at Oldham, a maximum of 1,875° was noted with a minimum of 1,370° for four new cells, and for a six-cell set a lower record was made. These worked at $1\frac{3}{8}$ inch water gauge, and the four cells at only $\frac{7}{8}$ inch, the lower pressure showing the better results.

Tables of results are appended to the report, the most notable figures being a percentage of 18·10 of CO_2 and 1·40 of free oxygen—figures showing an almost perfect air supply. The gases were, in fact, wholly composed of nitrogen, oxygen and CO_2; once only a trace of CO being present and never any hydrocarbons.

Nearly 33 per cent. by weight of clinker and ash is produced from the refuse consumed, and about 1 lb. of water is evaporated. Clinkering was found necessary every two hours at Oldham, and every $1\frac{1}{2}$ hours at Bradford.

The clinker and ash seem always to be used for mortar, than which no better use seems possible. Larger stuff can be used for road and footpath bottoming. Thoroughly



T F, Tipping floor: F B, Feeding bin; O F, Outlet flue; G, Grate; A P, Ash pit B F, Blast flue; M F, Main flue; C F, Clinkering floor.

Horsfall Furnace—Single Row.

burned stuff is absolutely safe for mortar making, and we suspect that it will give a considerable property of hydraulicity to mortar after the manner of the Italian puzzuolana or volcanic ash.

Finally, we cannot too much emphasise the importance of following the system of heat conservation adopted in the Horsfall destructor. Destruction may sometimes, perhaps, be accomplished when a boiler is set close up to the furnace in cases where refuse is dry and rich in combustibles, but it is a very risky proceeding, and no destruction worthy of the name can be properly attempted without attention to the important feature of refractory flues to the limit point of danger, beyond which point destruction, being once accomplished, no possible harm can ensue from the use of the heat in steam raising. It is quite refreshing to read a report on refuse destruction which does not claim a calorific value for refuse about equal to that of best Welsh.

ON OSCILLATORY AND ROTATORY MAGNETIC FIELDS, AND THE THEORY OF THE SINGLE-PHASE MOTOR.

By MICHAEL B. FIELD.

(*Continued from page* 441.)

We will now consider a squirrel cage rotor and determine graphically the relative magnitudes of the forward and backward fundamental fields.

Let us take a rotor that breaks down at a slip equal to 20 per cent. synchronism in a constant field rotating with a given velocity.

On the lines already laid down we draw a horizontal axis (fig. 4), along which we plot the slip in terms of synchronism percentages. At 20 per cent. slip we draw a line at 45°, and obtain the centre of our diagram at O. We then draw a circle of convenient radius from which we can obtain proportionate values for the rotor currents corresponding to any particular slip. To determine the relative magnitudes of the forward and backward fields at, say, 10 per cent. slip, or at a speed of 90 per cent. synchronism we join the points representing (100 ± 90) per cent. synchronism with centre O. The projections, $b\,f$ and $c\,g$, would represent to some scale the magnitudes of the two rotor current waves if the two fields were equal in strength. These lengths, $b\,f$ and $c\,g$, we set off along the radii, O b, O c, and compound with the respective magnetising current waves, as already ex-

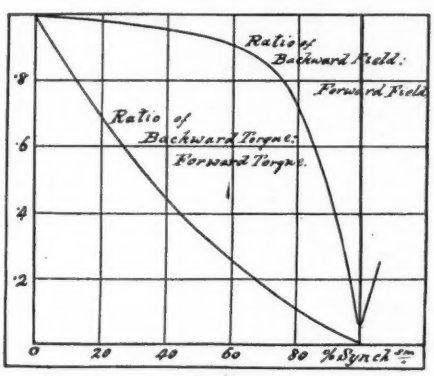


Fig. 7.

plained, obtaining as before the resultant current waves, O X_b, O X_f. If, now, we reduce the backwardly rotating field till O X_b = O X_f, the ratio of the two field strengths will be clearly given by the relation,

$$\frac{\text{Strength of backward field}}{\text{Strength of forward field}} = \frac{\text{O } X_f}{\text{O } X_b} = k,$$

and remembering the torque due to either field is given by the rotor C^2 R loss it produces, divided by the relative slip, we have

$$\frac{\text{Backward torque}}{\text{Forward torque}} = \frac{k^2\,(100-90)}{(100+90)} \cdot \left(\frac{c\,g}{b\,f}\right)^2.$$

The following table gives the results obtained by this very diagram, the magnitude of the magnetising wave having been chosen of such a value as would correspond to a practical case.—

Speed of rotor in percentage of synchronous speed.	Backward field as percentage of forward field.	Backward torque as percentage of forward torque.
0 per cent.	100 per cent.	100 per cent.
60 ,,	91 ,,	25 ,,
70 ,,	84·5 ,,	18 ,,
80 ,,	72 ,,	11·2 ,,
90 ,,	46 ,,	5·4 ,,
96 ,,	21 ,,	2·2 ,,
98 ,,	11·1 ,,	1·2 ,,
99 ,,	7·5 ,,	1·1 ,,
99·5 ,,	6 25 ,,	1·5 ,,
99·9 ,,	5 7 ,,	6·4 ,,
100 ,,	5·70 ,,	∞

This table is represented by curves in fig. 7; these are very instructive, we see how on starting the ratio of backward torque to forward torque is unity, this ratio, however, rapidly decreases as the rotor runs up to speed till at 99 per cent. of true synchronism the backward torque is only 1 per cent. of the value of the forward torque. At synchronism, however, the forward torque becomes zero, so that the curve flies off to infinity at this point.

In the foregoing work the leakage constant, L, has played an important part, and, it has been remarked, that the same might be determined for a given rotor by placing the same in a constant magnetic field rotating with a constant velocity, and measuring the slip at which the rotor breaks down or falls completely behind. It must, however, be pointed out that this slip is not the same as that at which the rotor would break down if placed in a stator supplied by two or three-phase currents at constant potential. In such a case the actual field existing in the air gap decreases considerably as the motor becomes loaded up, owing to the magnetic leakage of the stator windings, and in consequence the motor breaks down much sooner than it otherwise would do.

To illustrate this case fully a practical example has been worked out diagrammatically and represented by the curves of fig. 8.

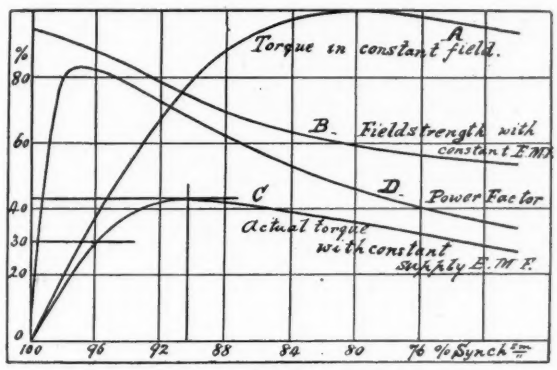


Fig. 8.

The following data were assumed for the motor :—

(1) That the rotor would break down at 20 per cent. synchronism in a constant field.

(2) That the full load or rated output of the motor is at a slip of 4 per cent. synchronism.

(3) That the magnetising ampere-turns are equal to ·307 times the rotor ampere-turns at the above slip.

(4) That the leakage coefficient of the stator windings, or the lines which do not thread through the rotor windings, divided by the total number threading the stator windings at no load is ·06 (= 6 per cent. leakage).

The curve A is the torque-slip curve that would hold if there were no stator leakage, in which case the field would remain practically constant for all slips (unless, of course, the ohmic drop in the stator assumed a large value). Calling the field strength in this case 100, curve B shows how it falls off in virtue of the 6 per cent. leakage as the slip becomes greater. Curve C shows the actual torque with 6 per cent. leakage coefficient; curve D represents the power factor.

The diagram employed for the determination of the above curves is shown in fig. 9, and needs but little explanation. O X represents the stator ampere-turns or merely the stator current, O p the E.M.F. due to the leakage of the stator winding, p q the C R drop in the stator, q r the back E.M.F. due to the resultant field F, hence O r is the supply E.M.F., and cos ϕ the power factor.

Various values for slip were chosen and the supply E.M.F. determined by working backwards from a given assumed value of F. The torque, power factor, and value of supply E.M.F. necessary were noted for each value, and the two former plotted giving curves A and D. Since, however, the supply E.M.F. as determined from the diagram does not turn out to be constant for different values of slip, it is only necessary to reduce F proportionately in each case plotting the values as a curve (B), and remembering that the torque is proportional to the square of F, the corrected torque slip, curve C, are easily obtained. It is to be noted that for a constant field, F, the value of the torque for any slip is always proportional to the length of the perpendicular f s drawn from the point, f, to the radius, O b.

For the case worked out (which represents the conditions obtaining in many an induction motor as actually built) we see that the maximum torque obtainable is only 43 per cent. of that if there were no magnetic leakage in the stator, whereas the rotor breaks down at approximately half the relative slip. The full load has been taken at 4 per cent. slip, the breaking down torque is thus nearly 50 per cent. in excess of the full load torque; the magnetising current is about one-third of the full load current; the maximum power factor is 0 83, and occurs at about three-quarter full load.

We see then that if we wish to determine L experimentally by placing it inside a two or three-phase stator, we should not maintain a constant potential at the terminals of the stator winding, but starting with a comparatively low E.M.F. with no load, raise the same as load increases at a rate easily deducible from the diagram for the particular motor in question.

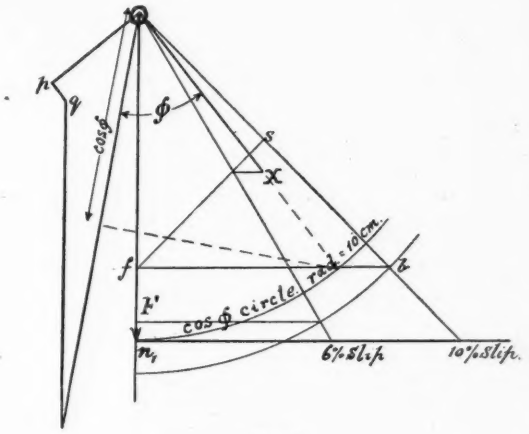


Fig. 9.

In dealing with wound rotors the coefficient of leakage may be most conveniently measured directly by supplying current to, say, the stator windings and comparing the induced E.M.F. in the rotor windings with the back E.M.F. in the stator windings.

(*To be continued.*)

MR. HANBURY AND THE TELEGRAPH CLERKS: A REPLY.

By CHAS. H. GARLAND.

(*Concluded from page* 488.)

From the evidence adduced it is fair to infer that the increase that has taken place in the salaries of telegraphists has been more than justified by the changing and progressing environment and the increasing demand for skill and education in the operator. Far from forming a reason for halting, the increase merely shows that in a reluctant manner the Post Office has progressed in a progressive period. Finality would only be possible by a stoppage of national development. The increase in wages paid does not even prove that Postal workers are adequately paid. Each increase is a tacit admission that the men were previously underpaid. An increase does not prove itself to be adequate because it is an increase.

We will now deal with some further assertions of Mr. Hanbury, and we hope to show that, far from being

generous, the salaries of telegraphists are not even what their terms of service promise. Col. Dalbiac (North Camberwell) raised a most important point, viz., the practical reduction of the maximum. On entry into the service the rates of pay were thus stated: "After a year at 16s. a week, to advance to £45 a year, rising by £5 to £100, with a prospect of attaining £190." "Now, Sir," said Col. Dalbiac, "of course we shall be told that the maximum has not been reduced from £190 to £160 at all, but that it is still in the power of everybody to obtain the maximum of £190. Well, Sir, I maintain that practically the reverse is the case. It is still possible, undoubtedly, for every man—I say 'possible'—to attain that maximum, but it is only probable that a very small number will ever reach it." To this Mr. Hanbury made reply: "No hope has ever been held out to any of these men that they would pass direct into the senior class, and reach £190 a year *without showing some special qualification.*" (Italics are ours.)

We have previously dealt at some length in the pages of the Electrical Review with the history of this question of £190 maximum. A brief recapitulation is necessary. The senior class, prior to 1881, was a class rising from £140 by £5 to £160. Complaints of "stagnation of promotion and inadequacy of pay," led Mr. Fawcett to alter the scales, and the senior class was put on a scale from £150 to £190 by annual increments of £8. As shown by the quotation from Mr. Fawcett's speech above, the main consideration for such an increase of maximum was the increased demand for skill and efficiency which the work made upon telegraphists. In writing to the Treasury upon the matter, Mr. Fawcett said: "The rates of pay . . . . are not more than sufficient to afford just and reasonable remuneration to those on whose efficiency and contented service so much of the interest and convenience of the community depend." There was here no mention of the "special qualification" which Mr. Hanbury declares was required before promotion to the senior class. Nor was any such qualification ever exacted before 1892. Men passed automatically into the senior class with no other qualification than that asked for each annual increment. But from that date a determined effort was made by the Department to make the senior class a "superior appointment" requiring special qualifications, and to wrest it from its position as an integral portion of the operators' scale. A technical examination was set which was eventually abolished as a breach of contract, and everything was done that was possible to convert the senior class into a supervising class. The attempt failed, but even yet the tradition remains, for in the most recent return of telegraphists' salaries issued in 1898 no mention is made of any scale reaching beyond £160 per annum. What becomes of the "prospect of £190" offered by the Civil Service Commissioners?

The contention of telegraph clerks, which is supported by incontrovertible evidence, is that £190 is the maximum of an operator, to which every operator has a right to rise; that the barrier at £160 is an arbitrary barrier, having no foundation in a differentiation of duty, and that it should be abolished. Mr. Hanbury said, "I perfectly admit that this senior class has been doing too much supervising work, but what we—the Duke of Norfolk and myself—did was to arrange that there should be a larger number of supervisors appointed, and we also did away with the technical examination for this class . . . . . which is now practically limited to men doing superior operating work, and to a few men who do supervising duties." In a return issued for Mr. Provand in 1894 the senior class was described as a "supervising class." Sir H. C. Fischer said in 1895 that it was "practically a class of lower class superintendents." Undoubtedly Mr. Fawcett treated it as an operators' class, and raised the maximum to £190 on that consideration. We have always claimed that it is an operating class, and to this view Mr. Hanbury now assents. Upon that ground we still urge the claim that it falls under the recommendation of the Tweedmouth Committee, conveyed in the following words: "Wherever in the case of officers not performing work of supervision classification exists, it should be abolished, and the officers, under certain conditions hereafter to be specified when we deal with the cases of particular classes, should precede by annual increments from the minimum wage of their class to its maximum." The minimum wage of the telegraphist class is 12s. per week, and the maximum is £190 per annum. The senior class is not a superior or supervising class, and all telegraphists have a right to proceed to that maximum without other than operating qualifications. It will be seen that the position of the Department with regard to this £190 maximum has undergone kaleidoscopic changes. Under the stress of circumstances it has been described as a "supervising class," as a "superior operating class," and as an "operating class." Throughout all these shiftings the position of the telegraphist has been consistently clear. The senior class was an operating class in intention and fact, and the remuneration fixed by Mr. Fawcett for operating abilities in 1881 was the inalienable right of the operator of to-day, and one to which the change of environment had strengthened his claim to such an extent as to demand a more rapid attainment. In place of this bare justice the maximum has been rendered practically impossible of attainment by the majority of men. So long as this inequitable condition remains, the hope of contentment in the Telegraph Service is a chimera.

It would occupy too much space to follow the maze of obliquities through all its devious windings; to note how a fruitless attempt has once more been made to get back to Mr. Raikes's ideal of resistance to postal unions by stirring up class jealousies and keeping the various bodies apart; to combat the mis-statement that one of the permanent officials of a postal union had been refused admission to the Trades Union Congress; or the avoidance of the subject of winter leave which involves reference to a promise made by Mr. Hanbury in 1897 and not yet redeemed. But the reference to the five years' case requires mention. "On the whole, I do not think that they (the five-year men) have very much to grumble at," said the Secretary of the Treasury. In the past the five-year men of the Telegraph Service were underpaid. Arrived at the age of manhood, they found themselves compelled to live on a bare pittance. Mr. Arnold Morley was so impressed with the necessity for a remedy that he was fearful of deciding it himself. Mr.—now Sir—H. C. Fischer told the Tweedmouth Committee that the men did not get enough to keep themselves. Mr. Preece said the same. Even Mr. Lewin Hill acquiesced in the claim for some improvement at this point. Yet, despite this testimony, they were given an increase of £1 per year, or 4½d. per week. But these boys, who had not sufficient to live on, were tantalised by the offer of two double increments, one for postal and one for technical knowledge. Fifteen have earned the postal increment in two years, and new entrants are not eligible to qualify for it. The technical increment costs more to obtain than it brings back in two years. Yet this is the solution offered to the question of pay that is "insufficient to live on" after five years' service. But said Mr. Hanbury, "on the whole, I do not think that they have very much to grumble at."

So far the questions of pay. The mover of the amendment raised the question of the rights of combination, and quoted a number of instances in support of his position that the full rights of combination were not enjoyed by postal workers. This, he said, was his "chief reason" for moving the amendment. Minister after minister has told us that the rights of combination are enjoyed by postal workers, and now Mr. Hanbury adds his statement to the list. "*The right of combination*," he says, "*is absolute.*" And, again, "They are at perfect liberty to combine with whom they like, how they like, and when they like." This seems definite enough. Yet it does not represent the facts of the case. The rights of combination, we assert, are *not* enjoyed by postal workers. Mr. Steadman introduced a number of instances in support of his position, and it is significant to note that not one of these instances is referred to by Mr. Hanbury in his reply. The most important rights of combined workmen are the rights of collective bargaining, the right to appoint its own representatives to represent any portion of its case, and the protection of those representatives from punishment for their connection with their union. Of many such instances Mr. Steadman quoted the following correspondence, which speaks for itself. On July 1st the Postal Telegraph Clerks' Association sent the following letter to the Controller:—

"We, the undersigned, beg most respectfully to ask you to receive us as a deputation to receive from us a petition of which we enclose a copy."

The following reply was received dated July 23rd:—

"With reference to the enclosed letter, I shall be happy to receive a deputation from members of the staff, but I cannot receive a deputation which purports to come from the Postal Telegraph Clerks' Association." Mr. Hanbury made no explanation of this, but it is interesting to set against it some of the passages in his speech. "The Post Office has done nothing to discourage these organisations in its officials at the Post Office." "There are two methods by which the Postmaster-General can be approached—first by memorial, and second by deputation. The only difference, the only thing which trades unions can complain of, is that the Postmaster-General will not allow outside interference, but does insist that these memorials shall be sent in by some one who is an employé, and the deputation shall also consist of employés." All these conditions were fulfilled in the letter quoted above, but the deputation was refused because it "purported to come from the Postal Telegraph Clerks' Association." This requires explanation. Then there was a further case, which Mr. Steadman put as follows: "Then take the case of Mr. Garland, who is the secretary of the Association. At the time when the agitation was on last year in reference to the refreshment branch, the superintendent arrogated to himself the right of selecting from the men the representatives to appear before the Controller. Now, had the men through their organisation had the right, the very man whom the superintendent left out of his selection, Mr. Garland, would have been the man selected by them." The matter was made the subject of questions in the House of Commons at the time, and subsequently the superintendent's selection was revised, and Mr. Garland was unanimously chosen as the authorised representative of the staff. This significant omission from the first selection requires an explanation, but Mr. Hanbury has not yet supplied one.

Then Mr. Steadman pleaded in vain for an explanation of the alleged threatening of a Mr. Ash because of his connection with the local branch of the Postal Telegraph Clerks' Association. Although this case involved the direct issue of intimidation, Mr. Hanbury made no reference to it in his reply.

The question of the rights of combination was not met by Mr. Hanbury. He, in common with the preceding representatives of the Post Office in the House of Commons, eulogised the value of trades unions and asserted that postal workers enjoyed all union rights. Yet when direct and unimpeachable evidence is brought to show that these rights are infringed and denied in actual practice he has no defence to make. It behoves him to see that the practice of permanent officials of the Post Office is in accordance with his assertion in the House of Commons. Otherwise his reputation must suffer, and the discontent which now honeycombs the service will inevitably be increased by the irritation which misrepresentation causes.

ELECTRIC PIPING.

Wiring rules are in the mouth of every man; they have got to be simplified, cut down, made uniform, so that every installation shall be carried out according to one set of rules only, and no man shall have to serve two masters. But while we are seeking to simplify and make uniform all these rules, no attempt is being made to standardise the many systems of electrical wiring into one ideal system, which should not only meet every requirement likely to be wanted, but should also greatly minimise the first cost of installation and the labour of those who will attempt to amend the said uniform set of rules. As in most things electrical, England lags behind in this matter also. On the Continent and in the United States, systems of tubing are almost universal, whereas here we still largely adhere to the antiquated method of laying wires in wood casings, compo pipes, or lead coverings, and occasionally we court danger by sinking these conduits in the plaster, a ready prey for the first picture nail that is driven into the wall. Naturally it is within the experience of everyone that a perfect ideal is unattainable, and it is therefore idle to set the impossible on a pedestal and worship it; but why should we not make an attempt to convert the attainable into the nearest approach to our ideal, and so if we cannot get quite what we want we may at least obtain the next best thing. Prof. Silvanus P. Thompson once stated that what is wanted is a system of electrical wiring which should be electric-tight, water-tight, gas-tight, air-tight, oil-tight, and rat-tight. If these be taken as the requirements of the ideal system, within what measure do the present methods approach it? It may confidently be stated that not one of these requirements, except the last, is *absolutely* fulfilled in any known system, although a system of iron piping would naturally more nearly conform to all of them except the first; and if sufficient care were taken in erection and fixing, and in details of connections, such a system might be said to be the nearest approach to the ideal. It seems to us that the present moment is most opportune for raising this important question; the Council of the Institution of Electrical Engineers is now considering the best means to be adopted to make the Institution rules universal; these rules attempt to deal with all systems of wiring, while no expression of opinion has been offered as to which system the Council thinks best; casing has almost entirely given place to tubing abroad, as we have mentioned before, and it is steadily being superseded here. Why, then, if wood casing (and other systems of conduit which offer no mechanical protection to the insulation) has to go, cannot the question of the best system of metallic conduits be considered by the Council of the Institution of Electrical Engineers at the same time as the question of rules to control the wiring systems, and in consultation with the fire insurance companies, the supply authorities, and the consulting engineers? No doubt, one great objection stands in the way—namely, that as there are several patented systems of conduits, any undue preference given to one system would be resented by the owners of other systems—and as it is avowedly the object of the Council to arrive at an understanding which shall please everybody, it would not do in the first instance to incur the hostility of certain contractors or to attempt to ram any one system down the throats of the large body of architects and consulting engineers who, after all, are possessed of a large capacity for employing and benefiting the wiring contractors. There are circumstances, such as houses where the interior decorations must not be disturbed, or oak panelled rooms, where casing will always be necessary, at any rate as a temporary expedient, and therefore its use cannot be abolished altogether. But it seems to us that the time has come when it would be desirable that such a body as the Council of the Institution of Electrical Engineers should, either by themselves, or in conjunction with those whom they are going to consult with regard to the wiring rules, give a definite expression of opinion against all forms of conduit which afford the insulation of the wires no mechanical protection. It can then be left to the experience of others to decide which is the best system of metallic conduit, and there is no doubt that time would quickly assist them in this matter. Perhaps the two factors which would more largely decide this point would be initial cost and safety. Pipe systems may be broadly divided into two classes, namely, the bare, or gas-pipe system, and the insulated pipe system. In the first class the wire which is drawn in must be highly and thickly insulated, to protect it from short circuits or "earths," and from mechanical damage. In the second class it is claimed that the insulation need be neither very high nor very thick, as the interior of the piping is insulated with a smooth substance. There is also a modification of both of these systems, namely, when only one wire is drawn through and the pipe itself is earthed; and there is a further system, which is really a hybrid, namely, one wire insulated and armoured, with an earth return. The latter system is by no means unimportant, but it is, perhaps, well enough known not to warrant further description. As regards the bare, or gas-pipe system, we have devoted space in our columns to this from time to time, and we think we have shown that, with good material, a well-thought-out scheme, a good arrangement of fuses, and, above all, thoroughly reliable workmanship, it can hold its own with any other system as regards solidity, and fairly well as regards expense, especially when upkeep is taken into account. It is now our intention to consider the claims of steel-armoured insulating tubing, with the object of giving those of our readers who have had experience with it, good or bad, or who have ideas or theories with regard to this, or what they may consider a better system, an opportunity of thoroughly dis-

cussing it, and some of the apparently heretical claims which are put forward on its behalf. Owing, perhaps, to the nature of the subject, it would no doubt be impossible to discuss it otherwise than in the press, and we therefore, while dealing with the system just as we have seen it, invite a discussion of its merits or demerits with a view to seeing whether it can claim to take its place amongst the candidates for a standard system.

Although steel-armoured insulating conduit is by no means a new thing now, like most other things it was new once, and like a great many things which are new, it hailed from America. But all this is a thing of the past, and it is now being manufactured in England by the Conduit and Installation Company, Limited (who have retained Mr. Fred. Bathurst as manager), which fact would seem to show that the makers, at any rate, have considered the system good enough to warrant the laying out of capital to manufacture it in England. Before proceeding further to discuss the system generally, it may be advantageous to shortly describe the conduit for the benefit of those who are not acquainted with it. As originally imported from America, the tubing was made in three forms—namely, an insulating tube only, a similar tube brass cased, and a similar tube iron armoured. These forms have now been dropped, for obviously if the makers wished to take mechanical strength as one of their main props they had to give up the first two varieties. The conduit as supplied now is called Steel-armoured Insulating Conduit, and this title sufficiently explains its construction. The insulating material consists of some form of bitumenised paper pulp, which, although it may seem anomalous, is claimed to be non-inflammable. The outer armouring consists of a welded steel tube, treated with composition as a protection against rust. There is no doubt that the system is well standardised, and it should not be difficult for a consulting engineer or architect, with a list of the fittings before him, to sketch out and specify a complete specification or inventory of material to be used in an electric lighting installation, measuring out lengths of tubing and number of boxes and other fittings and their position in every room of a building. This is what has long been required for the electric lighting trade—that an architect should get out a list of quantities of electrical runs, &c., in the same manner as he does in the case of tiles and bricks. The conduit can be set up either by screwing all the parts together or by sliding, so that the ends of tubing butt together in the sockets; but, of course, where the system is required to be water-tight, screwed joints only are recommended. Bends, elbows, and sockets are supplied for all sizes of the conduit, and with screwed or sliding connection; the curve of the bends is designed from experience of drawing in wires, and these are recommended, wherever possible, in place of elbows—and all those who have had any experience in the drawing in of wires will be careful to follow this recommendation. The sockets are made with the ends cupped out, so that an extra water-tight joint may be made by filling in with white-lead or other composition. The company supply two kinds of round joint, intersection, or outlet boxes. They have recognised that cast-iron boxes by their price and weight would militate against the extended use of the system, and although they list and supply these, as they must be used in cases of exterior wiring, or as a means of support for fittings, they make a much lighter and cheaper form of box, which is metal armoured with screwed nozzles cast into the box. Both these forms of boxes are supplied in nominal sizes of $2\frac{1}{2}$ and $3\frac{1}{2}$ inches inside diameter, and are fitted with insulating linings of a similar material to that inside the conduit. They are made in five varieties, namely, "outlet," "straight through," "corner," "T-joint," and "intersection," and are arranged for conduit from $\frac{3}{16}$ inch inside diameter to $1\frac{1}{2}$ inch inside diameter, or larger if required. In addition to this they can be used for the sliding connection system, where it is required to save labour and time, so that the ends of the conduit need not be screwed. For this purpose clamp reducing bushings are used. These consist of a split sleeve with a hexagon head at one end and coned on the outside. The coned surface is screwed to fit the nozzles of the boxes, and the inside is turned to fit the outside of the next size smaller conduit to that corresponding to the nozzle of the box. This bushing is slipped on to the end of the conduit with the coned end towards the nozzle; it is then screwed home by means of the head, and forms a very tight connection for the conduit. For these boxes two kinds of covers, with insulating lining, are supplied, of steel or polished brass, with flat or convex surface, for screwing into the box; the convex, or "dome" type, being more ornamental, is suited for use in surface work. As it is also necessary to be able at times to easily inspect boxes, the company have designed a form of clip cover, also in flat or dome type, and these are secured to the boxes by means of a slip cover adapter. One quarter turn of the clip cover removes it from the box. The flat type is provided with a small lug in the centre, to be used as a handle, and the dome type has a milled edge, which gives the necessary purchase.

In addition to these round boxes, a rectangular form is made. These are of cast-iron, and are strong enough to allow drilling. They are useful for sub-distribution or for placing at the back of switch or fuseboards, where they form an outlet for all the coming-in wires. The conduits being screwed can be fitted into these boxes if plain drilled by means of lock nuts, or if a better security is required by drilling and tapping the holes one size larger than the conduit, and using reducing bushings. The company supply a variety of small fittings, such as plugs, conduit caps, insulating nipples, clips, saddles, &c., all standardised to suit their conduits, and a very useful item is the insulating tube ends for screwing on to the end of a draw-in point. These are nicely rounded at the edges, and form a good prevention against damage to the insulation of the wires when these are being pulled through. In addition to all these things, a complete tool outfit for the working of the system can be had, and no doubt care has been taken to choose the tools best suited for the purposes required.

We next come to the wiring accessories. A considerable amount of ingenuity has been applied to designing a standard interchangeable set of outlet fittings, by means of which the ordinary brackets, pendants, &c., can be secured to the boxes; and the special ceiling rose, wall plug, lampholders, switch, and other accessories which have only recently been brought out, seem to meet every possible application that could be required for tapping the mains from the boxes. These accessories consist in all cases of a special china base with a tapped hole in the bottom; which screws on to a stud on the bottom of the $2\frac{1}{4}$-inch boxes for which all these accessories are arranged. Every base can also be supplied with an earthing terminal for putting one of the poles in direct electrical contact with the box. The covers provided for the boxes when fitted with these accessories are adapted for each particular use required. There are some covers with a single hole and insulating nipple for ceiling rose fittings, flat covers, with one or two holes for a switch or wall plug respectively, and even covers with thread for china ceiling rose cover if required, or gallery lugs for a shade.

(To be continued.)

THE WEHNELT INTERRUPTER.

There is a perfect chorus of agreement among experimentalists as to the remarkable results to be obtained by the application to the induction coil of Wehnelt's remarkable discovery described in the Electrical Review, February 17th. Mr. Campbell Swinton, who has shown the new interrupter at the Institution of Electrical Engineers and at the Physical Society, has discovered that the frequency of the breaks depends on the self-induction in the primary circuit. Prof. Silvanus Thompson infers from this discovery that the results obtained are due to resonance. It is well known that the layers of gas formed on the surface of the electrodes of an electrolytic cell act as a condenser of very considerable capacity. This capacity in circuit with the self-induction of the primary give the necessary conditions for the maintenance of rapid electric oscillations in the circuit. The disturbance required to start the oscillations is supplied by the layer of insulating gas periodically formed on the anode. Prof. Thompson publishes in a contemporary an account of experiments he has made which tend to confirm his theory. One of these experiments, which is a slight modification of one described by Wehnelt in his original paper, consists in connecting up a choking coil in circuit with a Wehnelt inter-

rupter and a source of current, and then connecting a glow lamp in shunt with the choking coil. It was found that a lamp of much higher voltage than the impressed E.M.F. could be lighted up. For instance, Prof. Thompson succeeded in lighting a 150-volt lamp from 100-volt mains; Wehnelt succeeded in lighting a 230-volt lamp with an impressed E.M.F. of 105 volts.

Dr. Macintyre, in *Nature*, reports that the Wehnelt interrupter immensely improves the efficiency of induction coils for the production of Röntgen rays. The one point in which the coil was inferior to the influence machine as a generator of X rays, was in the steadiness of the image on the fluorescent screen; this inferiority he considers has now been removed by Wehnelt's discovery. The only drawback that has been mentioned is that the discharge in a tube becomes so intense, that the platinum anti-cathode may be fused up or pierced in a few seconds if too large a coil is used. The remedy for this, as Elihu Thomson suggests, is to use a smaller coil. The massive electrodes devised by Campbell Swinton should also be useful in preventing the fusing of the anti-cathode.

Prof. Elihu Thomson gives an account of some interesting experiments he has made with the Wehnelt interrupter in the *Electrical Engineer*, N.Y., March 2nd, p. 239. He constructed an interrupter with a tumbler of battery acid (sp. gr. 1·2), a piece of platinum wire ·3 to ·5 mm. in diameter, and 2 cm. long, a piece of glass tubing 10 cm. long, a piece of sheet lead 3 cm. broad and 15 cm. long, with a wire or binding post attached. The glass tube is drawn down, and the platinum wire sealed in, so as to project about 1 mm. more or less from the end of the tube. It also projects into the tube, and the tube is bent at right angles a short distance from its end. Mercury is poured in, and a terminal wire is dipped in the mercury.

He recommends that a set of three or four platinum points should be made, and hung in the same vessel, suitable switches being provided to change from one to the other, or to couple them in multiple opposite the same lead plate. The several platinum points may vary in the extent of surface exposed to the liquid. One of them may have, for example, a wire of ·2 mm. diameter projecting only 1 mm., another may be somewhat larger and project about 3 mm., and so on.

Elihu Thomson's observations on the discharge from the secondary coil agree with those of other observers, but he observed some new results. When the usual jar condensers were connected upon a coil which normally gives a torrent of 7-inch sparks, the spark was shortened as in ordinary cases, but the effect became terrific. The noise was deafening, and a white stream of condenser sparks lighted up all the objects around with a continuous intense whitish blue light. He found that the secondary discharge was unidirectional when the air gap was near the sparking limit, otherwise with very high frequency he believes that the secondary discharge is oscillating. This is a point that ought to be settled by exact experiment, since it has an important bearing on the excitement of Röntgen tubes.

Elihu Thomson found, as did Swinton, that the frequency of the interruptions could be varied by varying the self-induction in the primary circuit. He found also that this frequency could also be varied by varying the area of the platinum wire exposed to the liquid bath, and by varying the impressed voltage. By lessening the platinum area the frequency was increased, as we should expect from Prof. S. P. Thompson's resonance theory. By increasing the self-induction greatly Elihu Thomson brought the frequency down to 10 to 12 per second; on the other hand, a wire core with a few turns gives an inductance so low as to result in an enormous frequency of interruption.

Elihu Thomson recommends having a number of platinum anodes, each in circuit with a coil of different inductance. In this way a kind of musical instrument may be formed, the switches playing the part of keys. The particular frequency best suited to the X ray tube may be found in this way and greatly enhance its efficiency.

The Wehnelt interrupter responds instantly to the closing of the switch, and this characteristic may be utilised for taking Röntgen screen images or photographs of moving organs of the body, such as the lungs, always in the same phase of their movement. The movement of the chest, in fact, may be caused to close the switch.

It appears to be important to keep the battery acid in the interrupter cool, since the interrupter ceases to work when it gets very hot. A cooling vessel outside the electrolytic cell is recommended for this purpose. Thomson sketches a design for an interrupter in which a lead T-pipe is used as the containing vessel, and this is immersed in a cooling tank. The platinum anodes are held in India-rubber stoppers pushed into the ends of the T, which is mounted in an inverted position. The acid electrolyte is poured into the open end of the vertical shank of the T.

Prof. S. P. Thompson found that if the pressure on the electrolyte is increased the current increases, and the regularity of the working was increased by inducing a circulation in the acid near the platinum anode.

It is evident that we shall not have long to wait before the Wehnelt interrupter is brought to a state of considerable perfection. The mechanical break apparently will soon be a thing of the past.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The meeting of the Institution of Electrical Engineers on Thursday last week was given up to Mrs. Ayrton's paper on "The Hissing of the Electric Arc." Mrs. Ayrton illustrated her remarks very fully by experiments.

The paper having been read, the President stated that in the ordinary course of procedure the meeting would at once have proceeded to the discussion, but it was not an ordinary occasion. He thought the last words spoken by Mrs. Ayrton, wherein the author expresses her appreciation of the honour paid her in accepting the paper, justified him in departing from custom, and at least in reciprocating the expression of feeling on the part of the members that had been expressed towards them. They felt on their part equally, or more than equally, honoured at Mrs. Ayrton having presented this communication, which was not of an ordinary description, but based on accurate observations and experiments, followed out in the clearest way, so as to become quite a model of scientific method and research. Discussion was a cold-blooded part of the business, but perhaps he might say that he felt very much astonished at the progress made. He remembered when the arc light was a perfectly new thing, followed by the days when spluttering, hissing, and frequent extinctions were the rule, due in some measure to the carbon themselves, which were cut out of some hard grade of carbon. It is wonderful that to-day such a high degree of perfection has been reached. Mrs. Ayrton has showed how it might be carried still further. He thought that the use of channelled carbons still found in lighthouses would not be continued.

The paper just read was the first placed before the Institution by a lady, but he knew that she would not desire that any allowance should be made on that account.

Prof. S. P. Thompson had hoped that Prof. Ayrton himself would have opened the discussion. He wished to voice his satisfaction that the Institution was the channel through which this very important paper was given to science: it was so essentially an excellent professional contribution to our science. Coming to the paper itself: in the first place it was clear that we had now got a new definition of a hissing arc; it shows a green colour, makes a noise, spurts and mushrooms, the surface is covered with a nebula or cloud, and its production is accompanied by a drop in potential difference. He was not quite sure that it was not the noise that defined a hissing arc. Two arcs were shown on the screen, one mushroomed and spurted, did that indicate the hissing arc?

There was a remark which recalled to Prof. S. P. Thompson the physics of the arc in times past. The statement was that, say, taking the diagrams given by Mrs. Ayrton, neither a hissing nor a silent arc could be maintained for 15 amperes with a particular length of arc. That was a fallacy; we were told that if we had an arc and kept the potential difference constant and lengthened the arc, the current increased. He ventured to point out that what actually happened was that to prevent the potential difference falling the current had to be increased. He was glad to find that Mrs. Ayrton supplied data to prove this. The action depended entirely upon what is going on in the external circuit. An arc could not be maintained with 15 amperes with that particular

E.M.F. in circuit perhaps, but double the E.M.F. and double the resistance, we would have the same current and arc, but the unstable portion of the curve would drop quicker and an arc of 15 amperes might be maintained. Mrs. Ayrton had shown how the behaviour of the arc is effected by the rest of the things in the circuit. Mrs. Ayrton has referred to revolving circles in the arc ; he thought Mr. Trotter's important discovery of the coma explained this.

He had intended to refer to shapes of carbons, as hissing is intimately connected with the shape of carbons. The access of oxygen complicates the action, but a good deal more is required to explain why that of itself should set up instability. He referred to the effect of boiling with bumping, where the surface is restricted and vapour is produced below the surface. He concluded by again expressing his very high appreciation of Mrs. Ayrton's labours.

Mr. Mordey thought the paper a record of thoroughly philosophical research. From the electrical engineering side we wanted arc lights to give light. The paper was interesting partly because of its bearing on that question. He thought it was not made clear if instability is necessarily an accompaniment of hissing. He had only once been in a lighthouse, but the arc was then hissing all the time. The channelling of arc carbons for lighthouse work added, in his opinion, to the use of the arc by allowing the light to get out. Sir James Douglass introduced that form of fluted carbon when engineer to Trinity House. The current used was alternating, and there was a large field to be explored in the physics of the alternating arc generally. He would like to mention a circumstance which had attracted his attention in connection with alternating current arc—the dark band, 1½ or 2 inches wide, which, with a low periodicity, say, 50 cycles, varied with a regular, steady pulsation, not connected with the periodicity, but 25 or 30 per cent. of that, say, 400 or 500 times in a minute. He had tried to ascertain the cause, but so far had not met with success.

He would ask Mrs. Ayrton to explain the cause of more granular appearance of carbons in enclosed arc lamps—this was very marked. He would repeat his admiration for the way in which Mrs. Ayrton had explained the subject.

The further discussion of the paper was then adjourned, to be resumed after the Easter recess on April 13th.

ELECTRIC LIGHTING IN THE CITY.

At the Guildhall on Monday Sir Courtenay Boyle, permanent secretary of the Board of Trade, opened an inquiry into the applications of the Smithfield Electric Supply Company, the Metropolitan Supply Company, and the Charing Cross Supply Corporation for provisional orders for the City of London.

Mr. Balfour Browne, Q.C., who with Lord Robert Cecil appeared for the Smithfield Company, said that there were three companies asking for orders, and the City of London Electric Light Company were resisting those applications. There was the question how they should proceed.

Sir Courtenay Boyle suggested that as all the applications were received by the Board of Trade on the same day they should be taken in the order of registration, and if that course was adopted the Smithfield application would be taken first.

Mr. Balfour Browne said that in the application of the Smithfield Co. power was asked to light St. Luke's and Holborn, but they withdrew that part of the application. At the end of 24 years the City Corporation had the power to purchase the public lighting plant of the City of London Electric Company's undertaking, and there was also power for the Corporation to compel the company to sell the private lighting at the expiration of a certain period. The late Commissioners of Sewers had no right to grant the City of London Electric Supply Company an exclusive right to supply the City, because under the Electric Lighting Act of 1888 it was distinctly laid down that the Board of Trade had the power to grant authority to two companies to compete in one district. The Smithfield Company was incorporated with capital powers of £100,000, and supplied the Market. The Metropolitan Company had a station at Willesden, while the station of the Smithfield Company would be within the City, which would be a great advantage to them. All the companies applying for orders must be in favour of competition, or they would not be there, and they had heard that owing to the want of competition, prices were high and the service bad in the City. If it were decided that competition should be allowed in the City, he contended that the company he represented was in the best position to supply, being, as they were, in the City, and tenants of the Corporation. With regard to the position of the City of London Electric Supply Company, no one could say that the local authority had the right to override the Act of Parliament. He did not suppose that the Board of Trade would allow all three companies to compete, and it became a question as to which company should be allowed to compete, and under these circumstances he contended that the Smithfield Company was in the best position to provide competition.

Mr. Cooper, electrical engineer to the Smithfield Company, said since the company had begun its operations he had been in charge of the works. At present they had a station in Charterhouse Street, and had 1,050 H.P. plant there. They had been supplying light to the Market from the date of the formation of the company. They supplied the avenues of the Market free of all charge. They supplied the tenants of the Market. They supplied continuous current low tension. A petition had been largely signed in favour of this company being allowed to compete with the City of London Company. Their petition had 9,000 signatures, and he believed the Charing Cross Company had 5,000 signatures. Up to the present time the supply in the City had been at high prices. The present price was 6d. per unit, but until recently it was 7d. per unit. The reduction, he thought, was due to the fear of competition. The supply of the City of London Company was alternating current, but the arc lamps, he believed, were lighted by continuous pressure. Ninety insurance companies had signed petitions. He had not the least doubt but what there would be a large demand for light supplied by them if an order was granted. They would soon be in a position to supply that demand, because they had the chance of acquiring an adjoining site to their present station, in which plant of 4,400 horse-power could be placed. At present they had spare power for 14,000 lamps, and they had vacant space to increase the plant to 2,000 horse-power. If the order was granted, that station could not be the chief station for lighting the City, but they would begin with it. The other companies would have to lay long mains, so that the Smithfield Company was in a better position to compete than they. Their plant at Charterhouse Street was in first class working order, and they had never had any complaints. They had made an offer to the City to supply at a maximum price of 5d. per unit with discounts which would bring it even lower. Current for power would be supplied at 2⅔d. per unit.

Sir Courtenay Boyle: Would you expect to supply more power than light?—No, but it would be a day load.

Continuing, Witness said their present cost of production for 10,000 lamps was 2¼d. per unit.

By Mr. Shiress Will, Q.C. (representing the Charing Cross Company): His company took the electric lighting station over as a going concern from two gentlemen. Their price for private consumers in the market was, he believed, 3·98d. per unit, and their gross revenue was £8,000 or £9,000 a year.

Cross-examined by Mr. Fitzgerald, Witness said by having a compact area and a long load they were in a favourable position for supplying cheaply at present. If they got a provisional order they would have to acquire a site and erect a further generating station. They would require about an acre of ground in the City in addition to what they had. When he said that, he had in his mind that they would require 15,000 H.P. They could get 20,000 H.P. on an acre. At present all their coal came to the Smithfield station in carts. It was cheaper to get material by water than by rail.

By Mr. Walter (for the Corporation): He did not know that the Corporation would not recognise the Smithfield Company. They were liable to have notice to quit at six months from the Corporation.

By Mr. Freeman, Q.C. (for the City of London Electric Company): There had been a suggestion to interfere with their monopoly of supply. He should not have thought that the private lighting of the City was practically confined to two hours a day for five days a week. He knew that the City of London Company could charge 8d. per unit, and he did not know that the price had been steadily reduced since 1895. His company had never paid any dividend as yet. He did not know that the City of London Company had 20,000 H.P., and that that was only just sufficient to meet the requirements. He did not know the City had made arrangements to increase their power by 5,000 H.P.

Re-examined by Mr. Balfour Browne, Witness said they had no demand for light on Sundays. To carry a main from Willesden would be very expensive. If they got an order he saw no reason why they should not make arrangements to have a siding in connection with the railway for their materials.

Mr. G. W. Butler, connected with Barclay & Co.'s Bank, Lombard Street, said the bank had been very dissatisfied with its supply and wanted the opportunity of going to another company for a supply.

Mr. Scheene, a director of the Smithfield Company, stated that if the company got a provisional order to supply the City they would have no difficulty in raising the necessary capital.

Mr. Fitzgerald: It would not be a very promising prospectus to put before the public would it?—I think so.

Although there was not enough profit to pay the debenture-holders one year?—It is not proposed to ask for money to carry on the existing business.

Further cross-examined: It would require about half a million of money to compete with the City of London Electric Light Company.

By Mr. Freeman: He did not know that the Smithfield undertaking before his company took it up had been hawked about the City. Their present capital of £110,000 was subscribed twice over by the public when it was offered 18 months ago.

This closed the case for the Smithfield Company.

Mr. Shiress Will, Q.C., addressed Sir Courtenay Boyle for the Charing Cross and Strand Electricity Supply Corporation, and showed the capital powers the company possessed. They had 104 miles of

mains laid altogether in the areas over which they had powers. The company attributed their success to the cheap supply, the thoroughly reliable and even pressure, and the readiness of the company to meet the demands of customers. They had had many requests to supply people in the City, and in 1897 wrote to the Commissioners of Sewers, asking to their consent to try and get powers. After having an interview with the Corporation the company were informed that the Corporation was unable to give its consent to the application. They had a petition signed by 5,000 persons, comprising 29 of the principal banks, 81 of the principal insurance companies, and a large number of newspaper proprietors and printers, asking for competition. Only the signatures of responsible persons had been obtained in that petition. In every part of the company's districts there was competition, and in one part of their district three companies were competing.

Sir Courtenay Boyle: It's a very small bit, isn't it?

Mr. Will said it was about one-third of the St. Martin's district. His company had found that competition lowered the price and increased the consumption, and in the end was best for the company. He could not see why the company would not agree to his company coming in for a competing order. They were perfectly prepared to carry on the lighting of the City under all the difficulties which might exist. It had been stated that the City of London Company had lowered its charge, notwithstanding that it had dropped its dividend; but he would prove that that reduction was illusory, inasmuch as a man would have to use the light for a great many hours to get advantage of the reduction. His company's average price was 4·36d., while that of the City of London Company was 6·22d.

Mr. E. Wilmot Seale, secretary of the Charing Cross Company, said the company had powers in St. Martin's, St. Giles's, and a portion of Holborn which adjoined the City. They had 142,000 lamps and 104 miles of mains. At the present time they had surplus power to supply the City, and as soon as the mains were laid they could proceed to supply. The present prices charged by the City of London Electric Company were too high, and only the wealthy could use it. If such charges had been made in their district they could not have had such a return as the City Company had.

You are prepared to supply the City at the same price you supply your districts now?—Yes.

And electric power at 3d. to 2d., according to the amount supplied?—Yes.

Continuing, Witness said that with the prices of electricity going down from 1894 to 1898, their dividends had been going up, and the number of lamps had increased three-fold. Taking lamps all the year round the average length of time they would burn would be 2·68 hours per day. The Metropolitan Company was nine times as large as theirs, and believed they had not enough energy to supply their own company. He did not believe there would be *bonâ fide* competition if the Metropolitan Company had their order given because one of the officers of the City of London Company was on the board of the Metropolitan Company.

Several witnesses were then called by Mr. Will to prove the failure of the City of London lighting and the high price paid.

Mr. Seale recalled, was cross-examined by Mr. Balfour Browne, and said that if an order was granted the company they would supply from their Lambeth station and from contemplated new sites.

Sir C. Boyle: What probability is there of your company acquiring a site?—I think there is every probability.

Further examined: His company purchased the private works of Messrs. Gatti for £70,000. They were actively competing with the Metropolitan Company and the London Electric Supply Company. They were already supplying light in Holborn from Lambeth. There was nothing in the provisional order to prevent them laying down mains in a district outside their area of supply. They had an agreement with the Lambeth Vestry to lay down mains, and by agreement with the London County Council brought mains across the river over the bridge. They supplied a large amount of current for motive purposes.

Mr. Walter: Would you be willing to put in a clause giving the local authority power to buy the generating station outside the district?—Within a period; yes.

Mr. W. H. Patchell, engineer-in-chief of the Charing Cross and Strand Company for six years was called, and endorsed the evidence of Mr. Searle.

The inquiry was adjourned at this stage.

LONDON COUNTY COUNCIL.

At a meeting of the County Council on Tuesday, the Parliamentary Committee reported having had prepared the London County Tramways Bill for the purpose of authorising the Council to adopt the conduit, trolley, or surface contact system on all or any of the Council's tramways. The schedule to the Bill contains particulars of lands in Streatham, Camberwell, Lambeth, and Greenwich as possible sites for generating stations, and now used as depots for general tramway purposes. Having regard to the period of the year, a suspension of the Standing Orders of Parliament will be necessary in order to allow of the introduction of the Bill, and the Parliamentary Committee stated that they had therefore given instructions for the necessary steps to be taken with a view to such suspension being obtained.

The Principle of Purchase.

With reference to the Central Electric Supply Company's Bill, the Parliamentary Committee stated that before the House of Commons Committee it was proposed that the power of purchase of the proposed undertaking should be reserved to the County Council in order to overcome the difficulty of purchase by more than one local authority after a period of 42 years. The House of Commons' Committee, however, passed the Bill, the Chairman stating that the Committee did not see their way to depart from the decision arrived at by the two Committees which considered the Metropolitan Bill last year. Commenting upon this the Parliamentary Committee said:—"The question involved is one of importance, which might, perhaps, be dealt with as a matter of public legislation by an amendment of the provisions of the Electric Lighting Acts with respect to purchase. It will be for the consideration of the Council whether or not the present Bill should be further opposed in the House of Lords with a view to obtaining some satisfactory arrangement with respect to the purchase of the electric light undertakings." The Committee accordingly recommended the Council to present a petition to the House of Lords against the Bill with this object in view.

Electric Traction in South London.

The Highways Committee reported that the conference (referred to in the last issue of the Electrical Review) between a subcommittee and representatives of the Lambeth Vestry and the Wandsworth Board of Works had taken place on the proposal of the Council to apply to the Board of Trade for a license to adopt mechanical traction on the tramways between Westminster Bridge and Tooting. The committee expressed the opinion that as a result of the conference those two bodies as the road authorities would give their consent to the experiment being made.

Prof. Kennedy, the committee further stated, was to have left for the United States last Saturday, in order to investigate the system in use on the tramways in New York and other cities, and it was expected that the advising engineer would probably present his report in from four to six weeks. In order to be able to speedily act upon the report the committee suggested that formal application should be made to the two local authorities above referred to for the permission necessary before approaching the Board of Trade.

The Highways Committee further asked the Council to sanction an expenditure of £150 in order to obtain for a month the expert advice of Mr. F. E. Cooper, M.I.C.E., to advice the Council in connection with the scheme for the construction of light railways in conjunction with the Council's tramways.

The Building Act Committee recommended the Council to approve the plans submitted on behalf of the City of London Electric Lighting Company for the erection of a furnace chimney shaft at the Bankside station.

PARLIAMENTARY COMMITTEES.

County of London and Brush Provincial.

Before the Select Committee of the House of Commons on Wednesday last week—Sir William Coddington presiding—was commenced the consideration of the County of London and Brush Provincial Electric Lighting Bill. Mr. Pember, Q.C., Mr. Balfour Browne, Q.C., Mr. Moon and Mr. Shaw appeared in support of the Bill, against which a large number of petitions had been presented.

Mr. Pember, Q.C., in opening the case, said that the County of London and Brush Company had a number of districts, some on the north side of the Thames and some on the south. The northern district included Clerkenwell, St. Luke's, Holborn, St. Giles, Mile End Old Town, St. George-in-the-East, Limehouse. Their southern district included Putney, Wandsworth, Clapham, Streatham, Tooting, Camberwell, St. Olave's, St. Saviour's, &c. The company at present had a very difficult series of problems to deal with in the way of mains and generating stations. The fewer generating stations the company had to maintain, the more economical it would be able to work, and it was very essential in the interests of the consumers that the company should be able to carry their mains from point to point by the shortest practicable route. The company therefore sought by the Bill to purchase additional land on which to extend their generating station in the City Road, on the Regent's Canal. On the south side of the river at Wandsworth they also proposed to extend their generating station and they sought to obtain compulsory powers to purchase a site for a generating station on the Surrey Canal, at Camberwell. The promoters also proposed to modify the provisions of section 9 of the Electric Lighting Act of 1882 as to the accounts to be rendered by the company.

Mr. Worsley Taylor, Q.C., who appeared for the London County Council, here interposed, and said it might perhaps save the time of the Committee if he stated that all the petitioners against the Bill had grouped themselves into various groups, as there were certain petitions which substantially involved the same points.

Mr. Pember, in continuing his address, drew the attention of the Committee to the report of the Committee on Electrical Energy which sat under the presidency of Lord Cross last session, and said that that report had a material bearing on some of the allegations made by the petitioners against the Bill. As to the power of purchase by the local authorities at the end of 42 years, that Committee had departed from the principle of the Act of 1882, as electrical energy was no longer confined to lighting purposes, and they had reported that it seemed undesirable that local authorities should purchase an undertaking supplying energy in bulk with a few mains at a high voltage, as a system with distributing mains at a low voltage, and to provide for any cases where it might be desirable, it was suggested that power should be given to the Board of Trade to insert a purchase clause if satisfied that there was good reason for so doing. His clients did not wish to go beyond or unduly press the

report of Viscount Cross's committee, which of course did not override any decision which the present Committee might come to, but he had no doubt that proper weight and consideration would be given to the conclusions of that committee. The main objection to their Bill was that of the London County Council, on the ground that it did not provide a power of purchase by the local authority. The County Council in support of their contention quoted the Acts of 1882 and 1888, but it must be remembered that in those years electrical energy was only in its infancy; besides which the Council was not the purchasing body, but the various local authorities were quite independent of the Council.

Mr. Preece, president of the Institution of Civil Engineers, and consulting engineer to the General Post Office, gave evidence in support of the petitioners, and said that in his opinion, instead of having a great number of small generating stations scattered all over London, it would be better to supply electricity in bulk from a few central stations scattered along the river, or by the main lines of railways. That system would conduce to economy in production, and he estimated that it would be possible to bring down the cost of electric light in London to 3d. or 2½d. per unit.

The Committee adjourned.

At the resumed sitting of the Committee on Thursday, witnesses were called by Mr. Pember, Q.C., on behalf of the company. The first to be examined was Mr. Lawson, C.E., the engineer and manager to the company. Replying to counsel witness said that at present the company had generating stations at St. Luke's and Wandsworth. At their St. Luke's station they possessed capacity for lighting 70,000 8-candle lamps, but they wished to extend the station to a capacity of 120,000 lamps. At Wandsworth, when the present site was enlarged, they would have a capacity to supply 240,000 8-candle lamps and 10,600 horse-power. They estimated that at Camberwell they would get about the same capacity as at Wandsworth. In all cases about 25 per cent. must be allowed for reserve.

What do you estimate your future demands at?—At Wandsworth we estimate that we shall need to supply 180,000 lamps in five years, in Camberwell 100,000, and in St. George-the-Martyr and St. Olave 30,000, making a total of 310,000 lamps.

Witness then gave a description of the site for the proposed station at Camberwell, and said that it was an exceedingly advantageous one in all respects. He had seen the petitions against the Bill, and those which came from landowners and occupiers whose property would be affected resolved themselves into the question of compensation. The company had offered an all night supply at the low charge of 3d. per unit; the ordinary charge being 7d. for the first hour and a half, and 3d. per unit afterwards.

Replying to Mr. Worsley Taylor, Q.C., for the London County Council, Mr. Lawson said that in all his company were seeking to supply 12 new districts with a population of 1,213,000. In his opinion they would not require further generating stations for that purpose, as they could get all they wanted by adding to their existing stations.

In reply to Mr. Earle, who represented the Battersea Vestry, the Witness admitted that the company had illegally laid down mains in the Battersea district, but he said that those mains still remained by permission of the Court of Appeal. They had applied for an order to suppy that district, but as it had been refused they were not asking now for such permission. The company had been treated most vindictively by the Battersea Vestry all through.

By Mr. Arnold Statham: If the parish of Islington desired, the promoters would enter into an undertaking not to supply electricity in that parish, notwithstanding that in order to supply Hackney they would have to go through a large part of the Islington district.

The witness was further examined by Mr. Talbot, for the Camberwell Vestry, and by Mr. Dickinson, who appeared for the Wandsworth District Board, and his cross-examination was not concluded when the Committee adjourned.

On the Committee re-assembling on Friday Mr. Lawson again took the witness chair, and his cross-examination was continued, when Mr. Vesey Knox examined the witness at some length as to the proposals of the company with regard to Shoreditch. The witness explained that the object of the promoters in wishing to carry their mains through Shoreditch was to serve districts beyond that parish in an economical manner.

Have you made any estimate as to what it will cost you to put up the generating stations and to lay the cables you propose under this Bill?—Yes. The cost of the St. Luke's extension will be £33,000 or £35,000. The total cost of the cables we should run under Shoreditch will be under £10,000. In all we may want to spend about £432,000. Continuing, the witness said that they had spent £58,866 in their northern district and £15,000 in Holborn. In Wandsworth their expenditure had amounted to £243,000, and to £45,900 in Camberwell. They had also expended money in provincial cities in connection with other undertakings, which had brought their total expenditure up to £562,587. The company had a called up capital of £400,000 in ordinary shares—upon which no dividend had as yet been paid—and in addition they had £200,000 6 per cent. preference shares which they issued at a premium. Witness admitted that the company engaged in financial operations as well as in electric lighting, but he denied that the present application could be regarded in that light. It was, he said, a *bonâ fide* application to obtain powers to supply electricity in London.

Re-examined by Mr. Pember, Witness said that no fair comparison could be made as to the charges of a company and that of a local authority. In the first place a local authority could save a good deal of capital expenditure by using existing offices, &c., and then they could borrow from the rates without having to pay any interest. He believed that the Shoreditch Vestry borrowed £20,000 in that way last year, for which they would not pay a penny interest. Then again, a local body did not rate its own machinery, although they took good care to rate the machinery of any company that was working in the parish.

Replying to the Chairman, the Witness said that the promoters were only asking under the present Bill for rights of way and sites for extending their existing stations and for a site for one new station.

You do not propose to take any new areas of supply?—No.

By Mr. Colville: The company would be in a very difficult position if they did not get their Bill through, because they would not be able to meet the demands which were sure to be made upon them in the future from Camberwell and other districts.

Sir F. Bramwell next gave evidence on behalf of the Bill, and said that, generally speaking, he agreed with the views of Mr. Lawson. He had visited, he said, the sites of the proposed extensions, and was of opinion that they were admirably suitable for the purposes to which they were to be put. They would result in more economical working, and that must be of public advantage.

Mr. Lawson was recalled, and said that the £35,000 he had mentioned as being the cost of the proposed extension at St. Luke's was merely for the extension of the buildings, and did not include the laying of the mains. In all, the total expense to which the company would be put under the Bill if they carried out all their wishes would be probably £200,000.

Mr. Pember said that that concluded the case for his clients.

The case for the objectors was then opened by the examination of Mr. Cripps, of the firm of Gooddy, Cripps & Co., who said he strongly objected to the Bill because under it the company would have power to acquire the wharf belonging to his company, and if that were done their business as marble merchants would be practically ruined.

The Committee then adjourned until Monday.

On Monday the consideration of the London and Brush Provincial Electric Lighting Bill was resumed.

Mr. Littler, Q.C., addressed the Committee for the Whitechapel Board of Works, and said that the broad objection of his clients to the Bill was that it embodied an order which, if granted, would do them a great deal of harm, and could not possibly do them any good. Whitechapel lay between St. Luke's, where one of the company's generating stations was situated, and several of their other districts in the East of London. Unless there was some almost imperative reason for passing through Whitechapel, or any other district which could not be benefited, no such Parliamentary power as that sought should be granted. It would inflict upon the petitioners considerable burden and responsibility, as their streets were honeycombed with underground mains, sewers, wires, &c., and were largely covered with wood pavement which could not be interfered with without loss to the road authority. Another objection to the proposal of the Bill was that, if the promoters were once allowed to pass through Whitechapel they might in some future session do something in the way of competition with the Board of Works, who were themselves supplying electricity. He held that there was something else behind the Bill—that the promoters contemplated something which the committee knew nothing about. If measures of this kind were allowed to pass they would soon have London riddled and honeycombed worse than it was at present with wires, and that not for the public advantage, but for the benefit of this private company.

Mr. George Whitehead Preston, clerk to the Vestry of St. Luke's, said the effect of the proposed works would be to deprive them of rates to the amount of £1,227.

Mr. Wheeler, Q.C., for the Vestry of St. Matthew's, Bethnal Green, submitted that the essence of the report of the committee of last year, on which Mr. Pember had relied, was that if the Electricity Generating Company could not find a generating station in its own district it might go into another district to find it. With regard to the special case of Bethnal Green, he protested against giving the promoters a roving commission to go where they liked, no streets being indicated as those through which they wished their mains to run.

Mr. W. F. Dewey gave evidence for the parish of Islington, and said his parish had already spent £200,000 on electric supply, and proposed to spend another £100,000. They supplied electricity for electric lighting at 3½d. per unit, for power during the daytime at 3½d., and for private lighting at 7d. for the first hour and 4d. for every subsequent hour. As an electric lighting authority they had a strong desire to reserve to themselves the streets down which the promoters were seeking powers to go. One of his objections was that the Bill as drawn in the clause dealing with accounts would render it impossible to acquire the company's undertaking in Islington. He knew it was said that the Bill did not enable the company to supply electricity in Islington, but the moment they had laid a main down a street there was nothing to prevent them from spreading wires transversely in order to supply private consumers. He maintained that Islington was not between St. Luke's, where the company's generating station was situated, and Hackney, which the company wished to supply with electricity. At present the streets of Islington were congested with electrical mains. His objection, no doubt, would be met by the insertion in the Bill of a clause declaring that electricity should not be supplied to private consumers in the parish of Islington.

Mr. Pember, Q.C., proceeded to inform the Committee as to the parishes affected by the Bill. He said that Battersea had obtained an electric lighting order in 1896, and Fulham in 1897, and no work had been carried out, though it had been commenced, and the same thing applied to Whitechapel, which had obtained its order in 1892,

and Stoke Newington, which had obtained its order in 1893. Hackney and Poplar had obtained orders in 1893, but nothing had been done. Lambeth had got an order in 1892, but had transferred it to a company in 1897. Islington and Shoreditch had got orders in 1893 and 1892 respectively, and were carrying out the work. Bermondsey and Rotherhithe were applying for an order and the company sought to supply them. In the case of Greenwich, an order had been granted to the company for a part of the district, and the company were asking for an order in that district. In the Lee district an order had been granted to a company to supply a part, and the present promoters were seeking to supply the district. The Bethnal Green Vestry were applying for an order, and so were the company. Camberwell was the company's district, and in Lewisham powers were being sought both by the authority and the company.

The Committee adjourned over the holidays.

Charing Cross and Hampstead Railway.

On Wednesday last week the Select Committee which is inquiring into this Bill again met to consider certain proposed clauses.

Mr. A. F. Jeffreys, the chairman, said the Committee had decided not to insert the clause asked for by the Duke of Bedford, requiring notice to treat to be given by the promoters in respect of the subsoil through which the proposed line would run under property on the Bedford estate. Clauses relating to the provision of workmen's trains were inserted at the instance of the London County Council, and the Bill was reported to the House for second reading.

CORRESPONDENCE.

Railway Block Signalling.

I have read with interest the correspondence which has been carried on in your columns for some few weeks with respect to Mr. Pigg's book on the above subject, although I have not seen, neither do I wish to criticise, the book referred to. But I certainly think Mr. Christopher J. Little's letter, contained in your issue of the 17th inst., deserves some slight criticism.

In the first place, the claim to being the inventor of *the absolute block system* is, to say the least, a somewhat comprehensive one, as, according to my own personal knowledge, all the railway block systems now in use have been evolved, not from one person's brains alone, but are combinations of very many different inventions, the result of many years practical experience of the requirements of railway working. It is not, however, quite clear what *the* particular system is to which Mr. Little lays claim.

Whether electrical, mechanical, or a combination of the two, or to the broad principle of not allowing any two trains following each other on the same line of rails, in the same section, at the same time.

If the latter, I am afraid that few railway men, even at so comparatively early period as 1865, would have allowed that the idea was new, as I am certain that apparatus both electrical and mechanical was in use for this purpose long before that time.

In fact, "in the year 1842, Mr., afterwards Sir William Cooke, proposed *the* absolute block system of working railways, and during the 50 odd years which have succeeded various modifications of Sir William Cooke's plans have been tried on nearly all the railways, with the result of finding that nothing short of the absolute block system *then recommended by him* will meet the present requirements."

With regard to the permissive block system, *i.e.*, that in which two or more trains are allowed in the same section; this, as Mr. Little states, is not the absolute block system. But it *is*, nevertheless, in use, in a modified form at the present time, in places where the exigencies of the traffic require it, such as slow goods lines and stations where there is a through running line, in addition to a platform line. The through running line being worked on the absolute and the platform line on the permissive systems.

Trusting Mr. Christopher J. Little may succeed in proving this claim and so obtain the £50,000 reward to which he considers himself entitled.

F. W. Cooke, M.I.E.E.

Marlborough House,
Holly Road, Retford, Notts.

The Wehnelt Interrupter.

Concerning the Wehnelt electrolytic interrupter, I herein enclose an extract from Gore's "Art of Electro-Metallurgy" (page 197), which will be interesting to the readers of your journal.

Hoping you will find space to insert it in the columns of your paper.

J. Strachan.

Electrolytic Vibrations and Sounds.—As long ago as the year 1801, Gerlom observed that mercury exhibited peculiar movements whilst acting as an electrode in electrolysis, and this phenomenon has been since investigated by Sir J. Herschel, Sir H. Davy, and others. According to G. Lippmann, the contraction of a globule of mercury (whilst acting as a cathode in dilute sulphuric acid), on the passage of the current, is due to a change in the capillary constant. (*Journal of the Chemical Society*, Vol. xi., p. 1,094.) It was whilst investigating these peculiar movements and searching for thermic changes in electrolysis, by passing an electric current through a solution of double cyanide of mercury and potassium with mercury electrodes, that I first heard a faint sound, and then observed the surface of the mercury covered with waves; and by further research was led to the discovery of electrolytic sounds; the dancing motion and musical sound being due to the alternate formation and destruction of films upon the mercury by electrolytic action. A paper on the subject in the *Proceedings of the Royal Society*, 1862, contains a full account of the phenomenon, and the influence of various circumstances on it.

The best liquid for producing the sounds consists of 10 grains of cyanide of mercury, and 100 of pure hydrate of potash, dissolved in 2¾ czs. of aqueous hydrocyanic acid, containing 5 per cent. of the anhydrous acid ("Scheele's strength"); the liquid should be filtered. The phenomena usually occur only at the negative electrode, and out of a large number of solutions examined, the only ones in which the phonetic vibrations occurred were those alkaline cyanides containing dissolved mercury. The quick-silver may be contained in two very small watch glasses submerged in the solution, and the current from either two Grove's or five Smee's cells, conveyed to the electrodes by platinum wires, protected, except at the ends, from contact with the liquid by means of tubes of glass or India-rubber. During the occurrence of the sounds the current itself is rendered imperfectly intermittent, and the arrangement may to a certain extent be employed for similar uses to those of a break-hammer. . . . .

Slater Lewis v. The Scientific Publishing Company and John Heywood.

Will you permit me, as the author of the defendants' book, to add a few words to Mr. Slater Lewis's letter of 21st inst.

The defendants' counsel was not called upon for any reply, and had, therefore, no opportunity of rebutting the plaintiff's allegations. The case broke down on his own showing.

Two of the instances of infringement relied upon by him were the expressions "good all round man," and "official mouthpiece of the Board," both of which were employed by me in articles published some months before Mr. Lewis's book appeared. As most of the other instances were of a like nature, it was easy to make up the 109 paragraphs. The plaintiff appears to have been under the delusion that he could copyright the English language; Mr. Justice Cozens-Hardy very properly decided that he could not do so.

The plaintiff claimed as the essence of his system the interlocking of the cost accounts with the commercial books. In my book I keep the two sets entirely distinct, exactly as I did in articles which I published 2½ years before Mr. Lewis's work saw daylight.

The judge has decided that there was no infringement of copyright. When, therefore, Mr. Lewis speaks of paragraphs being "without question confiscated from my work," and of "wholesale piracy," he is verging on libel, if not actually guilty of it. It would be wise to obtain legal assistance before he indulges his spleen in any more letters to the press.

I am quite content to leave to the readers the question of the relative merits of the two books. I, at all events, have not insulted the engineering profession by declaring that "only one factory in half-a-dozen is under thorough control," nor have I degraded the position of the general manager by placing among his "most important duties" the superintendence of the filing of letters and the tidiness of the offices, drawers, and cupboards.

Francis G. Burton.

Waterloo House, Poynton,
March 27th, 1899.

The K R Law.

In the Electrical Review, March 17th, I notice a criticism on my recent paper on the K R law.

Your reviewer makes the curious mistake of assuming I have worked from Prof. Blakesley's formula for an infinite line. My formula (4), however, is given on p. 65 Blakesley's "Alternating Currents," for the current received on an earthed line when $x = l$.

I have nowhere alluded to any serious discrepancy between Lord Kelvin's and Prof. Blakesley's conclusions. My figures rather illustrate the contrary.

I, however, consider Prof. Blakesley's method an advance on Lord Kelvin's, although neither can be regarded as final.

Some interesting figures would, no doubt, be obtained if the E.M.F. was treated as a variable, as suggested by your reviewer. But it was scarcely within the scope of my paper to do this.

W. Moon.

March 27th, 1899.

BUSINESS NOTICES, &c.

The Affairs of Easton, Anderson & Goolden, Limited.—A meeting of creditors of the above company will be held at the Guildhall Tavern, E.C., on April 12th, to consider a summary of the statement of affairs by Mr. W. B. Peat, liquidator. The deficiency account shows the amount at debit of profit and loss account at June 30th, 1898 (being loss on working from July 1st, 1893, to June 30th, 1898), as £28,717 odd; loss on working, July 1st to October 28th, 1898 = £4,945; special amounts written off at October 28th, 1898—goodwill £7,500, expenses of issue of debenture stock £5,782, patents (not valued) £15,267, patterns and drawings (not valued) £13,500. There has also been written off £9,697 for bad and doubtful debts, and £10,017 shares in other companies. The depreciated value of stocks, &c., is accountable for £44,479, making a total deficiency of £139,907.

Alexander v. The Automatic Telephone Company and Margowski.—Before Mr. Justice North in the Chancery Division on 23rd inst., plaintiff moved to restrain the defendants from acting upon a resolution to remove him from his office as a director of the defendant company and from preventing him carrying out his duties as such. The motion was the result of proceedings at an extraordinary general meeting of the company, where a resolution was said to have been put and carried; but it was alleged by the plaintiff that the meeting was so disorderly that no business could be done, and that if the resolution had been properly put it would have been lost. The defendants, however, contended that no poll was demanded, and that, therefore, the chairman's declaration that the motion was carried was sufficient. Mr. Justice North said he could not find any evidence to justify the statement that the resolution was carried by a tremendous majority. He was of opinion that the meeting was irregular from beginning to end, and that it was a disgraceful act on the part of the chairman, Mr. Margowski, to have declared the resolution passed when it had never been put, and the meeting had not been told what was going to be done. The chairman and a number of persons present seemed to have forgotten how to behave as gentlemen and men of business. The attempt to remove the plaintiff from the office of director failed, and the injunction must be granted. The parties, however, were all of them so wrong from beginning to end that he should not give either side one penny of costs.

Alleged Theft.—At the Greenwich Police Court last Thursday several men (named Williams, Smith, Clark, Gunning, and Rodd) were charged on remand with stealing electric cable (value £174), the property of the Crystal Palace District Electric Light Supply Company. Prisoners were again remanded.

The Aron Meter.—According to notice in the *London Gazette* the Board of Trade has approved the Aron alternating current meter deposited on November 11th, 1898, by the Aron Electricity Meter, Limited, also the manner of fixing.

Award.—The Lister Electric Light and Power Manufacturing Company, of Dursley, Glos., were awarded a First Award and Gold Medal for a dynamo exhibited at the Exhibition lately held in Auckland, N.Z.

Battery Cost Calculator.—The Electrical Power Storage Company are introducing an automatic price list for storage batteries, which gives the prices complete of batteries from 15 lamps at 40 volts to 300 kilowatts at 220 volts. We have received one of these automatic calculators, which consists of a very convenient arrangement of sliding scales showing the costs of complete batteries of various capacities.

Electrical Wares Exported.

Week ending Feb. 15th, 1898.

Port.	Value.
Aden. Teleg. mat.	£22
Amsterdam	80
Antwerp	244
Auckland	27
Bangkok	229
Barcelona	210
„ Teleg. wire	98
Boulogne	20
Buenos Ayres. Teleg. mat.	478
Calcutta	851
Cape Town	25
Clinde	156
Colombo	60
Delagoa Bay	1,832
Durban	3,001
Flushing	60
Gibraltar	538
Gothenburg	123
Hong Kong	150
Leghorn	122
Lisbon	48
Madras	5
Melbourne	762
Napier	10
Ostend	50
Port Elizabeth. Teleg. mat.	450
Shanghai	115
Singapore	178
„ Teleg. wire	61
Sydney	335
Trinidad	22
Wellington	77
Yokohama	935
Total	£11,374

Week ending Feb. 14th, 1899.

Port.	Value.
Adelaide	£575
Alexandria	46
„ Teleph. stores	116
Amsterdam	340
Antwerp	490
Auckland	143
Boulogne	82
Brisbane	23
Buenos Ayres. Teleg. mat.	683
„ Teleph. mat.	30
Calcutta	308
Canterbury	200
Cape Town	72
Christiania	22
Colombo	76
Copenhagen	297
Durban	692
East London	78
Hamburg	140
Hong Kong. 15 tons old Teleg. wire (value not specified)	...
Perth	2,724
Port Elizabeth	345
Rio de Janeiro	65
„ Teleg. mat.	867
Rockhampton	39
Rotterdam. Teleg. mat.	12
Shanghai	14
Singapore	312
Stockholm. Teleg. mat.	110
Sydney	1,133
„ Teleg. mat.	35
Toronto	8
Wellington	88
Yokohama	765
Total	£10,930

Foreign Goods Transhipped :—

Jersey and Guernsey. Teleg. poles	£75

Electrical Wares Exported.

Week ending Feb. 22nd, 1898.

Port.	Value.
Albany	£42
Amsterdam	84
Barcelona	10
Bombay	70
Buenos Ayres	130
Calcutta	74
Cape Town	183
Durban	126
East London	81
„ Teleg. mat.	2,747
Flushing	227
Fremantle	1,325
Gothenburg. Teleg. mat.	216
„ Teleph. mat.	875
Malaga	158
Monte Video	30
North Sea	5,843
Perth	320
Port Elizabeth	764
„ Teleg. mat.	421
Rangoon	1,575
Rosario	55
„ Teleg. mat.	61
Rotterdam	240
Singapore	45
Sydney	99
Trieste. Teleg. cable	2,050
Takiti	6,000
Yokohama	10
Zanzibar	24,480
Total	£48,341

Week ending Feb. 21st, 1899.

Port.	Value.
Adelaide	£104
Amsterdam	25
Beira	65
Bilbao	50
Bombay	120
„ Teleph. stores	12
Brisbane. Teleg. mat.	1,976
„ Teleph. stores	296
Buenos Ayres	438
Calcutta	249
Cape Town	309
„ Teleg. cable	18,480
Colombo	121
Copenhagen	380
Delagoa Bay	233
Durban	1,891
„ Teleg. mat.	282
East London	45
Fremantle	344
Hamburg	100
Hong Kong	251
Madras	55
Malta	169
Melbourne	3,916
Newcastle (N.S.W.)	8
Ostend	19
Otago	250
Perth. Teleg. mat.	200
Port Elizabeth	15
Rio Janeiro. Teleg. mat.	718
Rotterdam. Teleg. mat.	18
Shanghai	26
Singapore. Teleg. mat.	122
Stockholm. Teleg. mat.	69
Sydney	1,284
„ Teleg. mat.	159
Tientsin. Teleg. mat.	238
Wellington	613
Total	£33,600

Bankruptcy Proceedings.—The first meeting of creditors was held on Tuesday last at the London Bankruptcy Court under the failure of Charles & Blackwell, electrical engineers, London and Leicester. The debtors entered into partnership in October, 1897, and carried on business under the style of the Central Electrical Engineering Company. Accounts had been filed showing liabilities £1,626 (unsecured, £1,373), and assets, £571. The failure is attributed to the non-success of the flotation of the Steady Arc Lamp, Limited. A resolution was passed for Mr. W. M. Richards, accountant, Leicester, to wind up the estate in bankruptcy assisted by a committee of inspection.

At the Huddersfield Bankruptcy Court last week, a receiving order was made against James Edwin Stott, of 10, Wood Street, Byram Arcade, and 9, Westfield Road, Huddersfield, an electrician, trading as James E. Stott & Co.

Liquidations, Dissolutions, and other Notices.—At a meeting of the North-Eastern Telephone Company, Limited, at 22, Dean Street, Newcastle, on April 13th, the liquidator will give an account of the winding-up proceedings. A meeting of the Electric Date and Time Stamp Company will be held at 2, Moorgate Street Buildings on April 25th, for a similar purpose. The liquidator of the Hope-Jones Electric Organ Company will report about the winding-up of that company at 8, Fenwick Street, Liverpool, on April 25th.

Bristol Gas Company and Electrical Supply.—A curious contest has arisen between the Bristol Gas Company and the Civic Electrical Committee, or in other words, the Corporation of Bristol, and this occupied a Parliamentary Committee, of which Lord Derby was chairman, for a considerable time last week. The gas company asked for sanction for a Bill giving them fresh powers, of many kinds, including that to make a very large increase in capital but the chief point which occasioned controversy were clauses which would have authorised them to become competitors with the Corporation in electrical supply. The gas company did not, of course, ask for power to lay electrical mains in the streets, but they proposed to supply gas engines, dynamos and electric motors, and to get authority to make such a reduction in the charge for gas supplied for such purposes as they might in their discretion decide upon. This would have practically repealed the present provision which gives the Corporation, as very large users of gas a most favoured customer clause, and it was suggested by the opponents to the Bill that what was likely to happen would be this:—The gas company would be under no obligation to supply motors and means for producing electricity to small users, but might pick out big concerns, such as hotels, manufactories, and business premises, and offer them such terms as would induce them to manufacture their own electricity with the aid of the appliances and the gas supplied by the company. It was even suggested on behalf of the Electrical Committee, that in their keenness to cut the ground away from the Corporation, gas might be supplied for the manufacture of electricity at a price which was unremunerative, the loss having to be made up by the general consumers of gas. At the conclusion of the gas company's case, Lord Derby, the chairman of the committee, intimated that the committee would not allow the gas company to interfere with the electric lighting or electric motive power of the Corporation. Evidence was then given by Mr. George Pearson, chairman of the Bristol Electrical Committee, and others, including Mr. Preece. Reference had been made by the Bill promoters to the fact that the Corporation was charging or proposing to charge greatly reduced rates for electricity for motive power, and Mr. Preece, in drawing the attention of the committee to the effect of a larger output, stated that in June there were 35,000 units of electricity manufactured at Bristol at a cost of 4·8d. per unit; whereas in December the output rose to 195,000 units, and the cost fell to 1·51d. per unit. Discussion arose on the wording of the clause intended to give effect to the Parliamentary Committee's wishes, and the committee decided that, while reference to electrical appliances must be struck out, the company should be at liberty to differentiate in the rate charged for motive power and lighting.

Electric Pumping Machinery.—The *British Australasian* says that the Minister of Works at Sydney has accepted the tender of the Clyde Engineering Company, amounting to £19,847, for the supply of electrical pumping machinery for use in low levels in connection with the sewerage system. An American manufacturing firm sent in a tender at £19,613. Mr. Young accepted the local tender on the ground that it would pay the exceptional cost to have the work carried out under the eyes of the department.

Gillingham.—The tender of Messrs. Priestley & Taylor (Leeds) has been accepted by the District Council for fitting up the Technical Institute at New Brompton, Chatham, with electric light at £107 17s.

Glover v. Glover.—At the sitting of the Chancery Court of Lancashire in Liverpool on 27th inst., Mr. Maberly moved, on behalf of the plaintiffs, W. T. Glover & Co., Limited, against the defendants W. James Glover (established in 1818), Limited, to restrain the defendants from carrying on business as electrical cable and electrical wire manufacturers under any title of which "Glover" forms part, on the ground that "Glover's cables" had acquired the signification in the trade of being electrical cables made and sold by the plaintiff company. The defendant company had just been formed, and their prospectus came out at the end of last week. A firm of W. James Glover & Co. might be carried back to 1818, but that business was one simply and solely for the manufacture of cables for haulage, and not in any sense electrical cables. Since the 17th inst., when the action was started, an advertisement had appeared in the form of a letter in the *Manchester Courier* stating that in consequence of this action the company would not go to allotment, and applicants for shares would have their money returned to them. His Honour, Vice-Chancellor Hall, observed that this rather altered the position of matters from the point of view of granting an injunction, because the defendant company was now reduced to a mere shell. Mr. Sutton, for the defendant company, said his clients desired to have the question tried as soon as possible. They had felt it right to return over £14,000 already subscribed, but they meant to fight the case, and fight it hard. The facts would be very complicated, and one question would be whether the defendants intended to act fraudulently, or at any rate to deceive the public. Mr. Maberly said that was not an issue that had to be tried. His Honour said things must remain *in statu quo* until the trial of the action. The flotation of the defendant company would sleep for the present. Nothing was proposed to be done which would interfere with the defendants carrying on business in the way they had been accustomed to do up to the trial. As to what their rights might be afterwards, he did not know. There would be liberty to the plaintiffs to bring on the motion again at any time if so advised.

A Hanley Bankruptcy Appeal.—Yesterday, in the Bankruptcy Division of the High Court before Mr. Justice Wright and Mr. Justice Bigham, sitting as a Divisional Court, the appeal came on for hearing in *re* Whitehead, debtor, *ex parte* the Edison and Swan United Electric Light Company, from the Hanley County Court. Mr. Muir Mackenzie represented the appellant, the debtor, and Mr. Carrington appeared for the respondents. The appeal was from a receiving order made against the debtor, who is an engineer, on the petition of the Edison & Swan Company, and the ground of the appeal was that at the time of the act of bankruptcy there was not a sufficient debt due to support the petition. The Act of 1883 provided that no person was entitled to present a petition unless the debt amounted to £50, and Mr. Mackenzie took the point that the £50 must be due at the date of the act of bankruptcy. It appeared that Mr. Whitehead received goods from the company on sale or return. He had previously dealt with the Manchester Edison & Swan Company, who were taken over by the United Company, together with all the arrangements they had made. At the time of the transfer the debt due from Mr. Whitehead to the former company was £92 10s. On June 25th, 1898, the Edison and Swan United Company commenced an action for £105 14s. 7d., which included the £92, and £13 4s. 5d. for further goods supplied. The debtor resisted the claim with the exception of £19, which he paid. He returned goods to the amount of £50 15s. 6d., and was given credit for £69 16s. 3d., leaving £35 18s. 4d. due. On January 13th, 1899, judgment was given for that amount with £25 0s. 7d. costs, but on January 10th the debtor had executed a deed of assignment for the benefit of his creditors, and the point was that at the time of the act of bankruptcy the debt was only £35 odd, the costs in the action not becoming due until after judgment. Mr. Herbert Reed, Q.C., argued that the costs became a part of the original debt, and that there was nothing in the Act of 1883 to prevent its recovery. Their Lordships, however, decided against this view and allowed the appeal with costs.

Lists.—We have received from Mr. Joseph Edmondson, of Bradford, lists giving description and testimonials of Edmondson's and Dawson's patent starter for gas engines.

New Electrical Works.—It is stated that a Sheffield firm of electrical engineers has secured a site in Unstone on which to erect works.

New Telephone Patents.—Mr. Commissioner Kerr disposed of an action in the City of London Court on the 24th inst., in which Mr. Edwin N. Henwood, Great St. Helen's, E.C., sought to recover from the defendant, Mr. Thomas J. Howell, electrical engineer, Barford Street, Liverpool Road, the sum of £40 and a declaration that he was entitled to a tenth of his receipts in respect of a new telephone. Mr. Shaw appeared for the plaintiff, and Mr. John Black for the defendant. From the evidence it appeared that the defendant, although blind and very deaf, had invented a valuable telephone transmitter. He wanted to put it on the market, and he came to the plaintiff for assistance. The plaintiff's case was that the defendant signed an undertaking to give him 10 per cent. commission on all money raised at once (funds being urgently needed with which to take out foreign patents) and a tenth share of all future benefits. The plaintiff had introduced the defendant to Messrs. Mercer and Locock, stockbrokers, who were to have formed a syndicate, and who advanced to the defendant £300 on account. The defendant had taken the matter elsewhere, and was about to receive 4,000 shares in a company. The plaintiff asked to be paid the balance of commission on money actually received by the defendant, and to have assigned to him 400 shares. In his evidence the defendant admitted receiving some money, but he said the shares had not been transferred to him. He denied knowing the full extent of the plaintiff's commission note. The telephonic transmitter which he had patented had been considered by the Duke of Norfolk, the Eastern Telegraph Company, Mr. Preece, of the General Post Office, and the Corporation of London, in reference to establishing a system in opposition to the National Telephone Company. Negotiations had been entered into with the Post Office authorities for granting a license. The plaintiff had assisted him no doubt, but he had no right to a tenth of the full benefit which might accrue. He did not sign the letter knowing its contents. The plaintiff had taken advantage of his blindness. Mr. Commissioner Kerr, according to the *Times*, said that was a serious allegation to make against the plaintiff. He could find no ground for it. There must be judgment for the plaintiff for £40, and for a tenth of the shares which were about to be given to the defendant by the company, which it had been shown was just coming out to work his patent.

Oxolin.—From the British and Foreign Oxolin Company, Limited, we have received sample and lists of oxolin. The lists detail the uses and advantages of the material as a substitute for India-rubber and for other purposes.

Paris Exhibition.—We are informed that the French Government are taking special steps to protect the Paris (1900) exhibitors in the matter of patents, designs, &c. The Royal Commission for the Paris Exhibition have been officially informed by the Consul General of France that a Bill will shortly be laid before the French Chamber, in which certain clauses referring to the invalidation of patents are suppressed. The Act of 1868 will be re-enacted on the present occasion with some amendments. It will give the owner of a design the rights conferred by patent from the date of admission to three months after the close of the Exhibition without prejudice to any patent or registration which he may effect before the expiry of that period. This gives a longer protection than is afforded in similar cases in the United Kingdom by British law, which specifies that application for the registration of the design must be made before or within six months from the date of the opening of the Exhibition. Her Majesty, by an Order in Council dated February 2nd, 1899, has declared that the provisions of Sections 39 and 57 of the Patents, Designs, and Trade Marks Act of 1883 shall apply

to the Paris Exhibition of 1900. This relieves exhibitors from the conditions specified in the said Sections of giving notice of their intention to exhibit. The new French Act, it is believed, will give British subjects greater protection than the ordinary British law affords to French subjects; and this, coupled with the fact that French judicial decisions have no effect as binding precedents, should allay any fears which British exhibitors may entertain with regard to exhibiting at the Paris Exhibition of 1900.

Parliamentary Bills.—In the House of Commons on Monday the Central Electric Supply Bill and the St. James's and Pall Mall Electric Light Bill were considered and ordered for third reading. The Kensington and Notting Hill Electric Lighting Bill was read a second time.

Personal.—We are informed that Mr. Frank Little, late installation superintendent for Mr. John A. Edmondson, Leeds, is to manage the Bradford branch of the National Electric Free Wiring Company, Limited, Faraday House, London, W.C.

Smoke Nuisance.—On Monday the Charing Cross and Strand Electric Supply Corporation, Limited, were summoned for disobedience to an order requiring them to abate a smoke nuisance upon their premises. Mr. Avory, for defendants, said that his clients had put in the best possible furnaces, and the fuel they burnt was the best Welsh coal mixed with coke to diminish the smoke as far as possible. They were under a statutory obligation to keep up a supply of electricity, and in these circumstances he submitted that, under Section 24 of the Public Health Act, they were entitled to claim exemption from further proceedings. Sir James Vaughan eventually adjourned the summons *sine die*, that the defendants' furnaces might be examined as to their efficiency by an expert to be nominated by the President of the Institute of Civil Engineers.

The Clontarf Council complained to Dublin Tramways Company recently of the annoyance caused by smoke issuing from the Dollymount electric power station. The company has promised to take steps to remedy the nuisance.

Theft.—Denis McMahon was found guilty, and a man named Gaynor pleaded guilty of the larceny of wire from the Cork Electric Tramway Company at the Cork assizes last week and were each sentenced to three months' hard labour.

Trade Announcements.—Mr. Joseph Blackburn, electrical engineer and contractor, of Gresham Works, Nottingham, informs us that he has made arrangements for the introduction of further working capital into his business by converting it into a private limited company, and has registered same as "Blackburn, Starling & Co., Ltd." No change will be made in the management of the various departments, nor will any shares be publicly offered.

Ventilating Fans.—The Edinburgh Markets Committee has adopted the scheme of the Wing's Disc Fan Company for ventilating Waverley Market. Ten fans placed in the ends of the light wells in the roof will be driven by means of electric motors.

W. J. Glover & Co. (established 1818), Limited.—We are requested to insert the following notice:—

William James Glover & Company (established 1818), Limited,
Warrington and St. Helens.

NOTICE.

You have our authority to state that in consequence of the action taken against this company by Messrs. W. T. Glover & Co., Limited, of Salford, challenging the right of this company to use the name "Glover" as applied to "Electric" cable-making, although the firm of Wm. Jas. Glover & Co. has been established for over 80 years, and long before Messrs. W. T. Glover & Co. came into existence.

No allotment of shares will take place on the numerous applications sent in, and the money received on application will be returned forthwith.

Yours truly,
William James Glover & Co., 1818, Limited.

Secretary,
F. G. Fairhurst.

By order of the directors.

ELECTRIC LIGHTING NOTES.

Arbroath and Kirkcaldy.—A deputation from the Corporations of Arbroath and Kirkcaldy waited on the Board of Trade on 24th inst. with reference to a clause in the Electric Powers Clauses Bill, which proposes that local authorities shall be prohibited from transferring powers conferred on them by provisional orders under the Electric Lighting Acts. The deputation pointed out that local authorities are at present free to transfer these powers to private companies, and urged that the law should not be altered in the manner proposed. Sir Courtenay Boyle told the deputation that in view of their desire to retain the power of transference and the circumstance that the Board of Trade may not have given adequate notice of their intention to propose this change, he would recommend the President of the Board to strike the transfer clause out of the Bill.

Bangor.—Last Friday the Lighting Committee resolved to recommend the Council to allow the now memorable electric lighting bond to be withdrawn on condition that the bond is given up to the town clerk by the leader of the electric lighting party.

Bedford.—The statement of accounts for the year upon the electric light works show receipts for the year of £5,873 19s. 8d., and a balance carried to the net revenue account of £2,177 14s. 5d. A new boiler, with mechanical stoker, is to be purchased at £1,350; also additional high tension cables.

Bath.—The Electric Lighting Committee having considered the Brighton system of charging for current cannot recommend its adoption for Bath, neither can it advise any change in the method in vogue at present. The extension of arc lighting to Lower Bristol Road is not recommended, but low tension mains with incandescent lamps are suggested. Mr. Metzger has prepared such a scheme. The tender of Messrs. Samuel Thomas & Co. for the supply of 3,000 tons of coal at 14s. per ton, for the next 12 months, has been accepted. The Art Gallery and Technical Schools are to be lighted electrically.

Last week the Council adopted a report of the Electric Lighting Committee, which showed that on the year's operations there was a slight loss. The Committee was to consider the subject of extensions at a subsequent meeting.

Bournemouth.—At the Bournemouth County Court last week Mrs. West was sued by the Bournemouth Electric Supply Company for £2 18s. 8d. for electric current supplied. Defendant admitted owing £1 6s. 6d., but said that the meter did not record correctly. Judgment was given for the plaintiffs.

Bristol.—The Council has resolved upon the Electric Light Committee's recommendation to purchase property closely adjoining the electricity works for the purpose of extensions, instead of buying land elsewhere for a second station, as had been suggested at an earlier stage.

The Electric Lighting Committee has resolved to carry out several further main extensions. Inquiries are to be made as to the desirability for extending the mains in Silverthorne Lane and Rupert Street.

Bury.—On 22nd inst. a Local Government Board inquiry was held *re* the Council's application for a £20,000 loan for extending the electricity plant.

Cardiff.—In reply to criticism of the electric lighting accounts at the last meeting of the Lighting and Electrical Committee, Alderman Carey said that for the first year's working the Committee lost £2,023, the second year they lost £1,200, and the third year there was a profit of £60. It was resolved that the town clerk be requested to lose no time in dealing with the case of Messrs. Ferranti, who have not yet handed over the engine which they undertook to complete in December, 1896. The electrical engineer reported that the engine in question would be ready for re-starting in a few days, and thought it might shortly be taken over by the Committee. The Committee instructed Mr. Applebee not to take any steps in connection with the contract without consulting the town clerk.

Clontarf.—The provisional order has been practically approved by the Board of Trade, but the question has arisen of the insertion of a clause allowing for the transfer to a company. The District Council will press for the insertion of the clause.

Darfield.—The supporters of the District Council's scheme for the lighting of the township with electricity were returned at last Saturday's elections. A local correspondent says, "The rateable value of Darfield is £25,000, its population 4,000. The scheme would entail a charge of 11s. per annum per head of the population. Most of the residents are miners. Every house would have to take the light or it could not pay, yet the promoters of the scheme are returned to the Council!" We gave a few particulars of Mr. Johnson's estimates last week.

Dublin.—The offer of the Municipal Industries Syndicate, Limited, has been discussed by the Corporation and marked "read."

Dundee.—The electrical engineer is to report upon the large number of tenders submitted for the boilers, &c., required in connection with the extension of the electric light station.

Edinburgh.—The Electric Lighting Committee has reported that the number of lights applied for since February 23rd last was equivalent to 5,471 8-C.P. lamps, and that the number connected with the supply from the 1st to the 17th inst. was equivalent to 6,570 lamps of 8 C.P. The Committee recommend that an estimate amounting to £8,827 be accepted for the formation of a subway between the M'Donald Road power station and Picardy Place.

Epsom.—The Council has instructed the clerk to have specifications of electrical plant, &c., printed, and advertise for tenders.

Greenock.—At last week's meeting of the Police Board, Mr. Anderson stated that the total amount of the estimates for the electrical plant and buildings in Hunter Place was a little over £31,000, slightly in excess of Mr. Fedden's estimate; but that had been entirely brought about in consequence of a very material increase in the price of copper and other things. It was expected that the works would be in operation by October or November.

Hackney.—The Vestry has had a lengthy debate regarding the amount of commission to be paid to Mr. Hammond in respect of the electric lighting undertaking, but the 5 per cent. proposal has been carried by 45 votes to 19.

Halifax.—In his summary of estimated expenditure for the current year the chairman of the Finance Committee calculates the electricity profits at £2,000. It is not proposed to reduce the present prices for current during the year.

Heckmondwike.—Last week the chairman of the District Council said the delay which had occurred in connection with the electric lighting scheme was due to their endeavouring to utilise the boilers of one plant for both electric lighting and public baths. He stated, however, that the preliminaries in connection with the electric lighting scheme would soon be completed, and the work pushed forward.

Hereford.—The contract for the electricity works' buildings, chimney, and lightning conductor has been given to Messrs. W. P. Lewis & Co. at £2,752. The ironwork contract has gone to Messrs. Alexander & Duncan, of Leominster, at £394.

Ingleton.—The Settle District Council has approved of the Ingleton Electric Lighting Committee's application for a license.

Kensington.—The Vestry has received a letter from its solicitors intimating that it was hoped that the agreement between the Vestry and the joint companies would be completed in the course of a few days, inquiring whether the House-to-House Electric Light Supply Company had been brought into line with the other two companies with regard to the supply of electricity at a fixed price for public purposes, and for private consumers, and asking whether they might withdraw the Vestry's provisional order on exchanging agreements with the solicitors to the joint companies. The vestry clerk had been in communication with the House-to-House Company and had received a reply pointing out that they were the first to offer to supply electricity for public lighting at 2½d. per unit, from which proposal the directors had no intention to withdraw, and further stating that the company had long had it in contemplation to reduce the price to private consumers as soon as possible. The committee, whilst they were of opinion that the assurance given by the company was a satisfactory one, so far as it went, had thought it well that the terms thereof should be embodied in a short formal agreement, and they had accordingly instructed the Vestry's solicitors to prepare the necessary document, and upon the same being executed by the company to withdraw the Vestry's provisional order. This course has been approved by the Vestry.

Kingston-on-Thames.—The District Council is applying to the Local Government Board for sanction to borrowing £15,000 for electric lighting extensions.

Liverpool.—On the advice of the city electrical engineer the Electric Power and Lighting Committee recommends that the following prices be charged, as from April 1st, for the supply of electrical energy:—For lighting, 4d. per unit; for power, up to 3,000 units per quarter, 2d. per unit, for each unit over 3,000 units 1d. per unit; for Corporation lighting of streets, 2d. per unit; and for Corporation lighting of buildings, &c, 3d. per unit.

Llandudno.—Last week the chairman of the Urban District Council, recounting the local municipal achievements of the last year, alluded to the electric light, and said that the most sanguine person present had not been prepared to guarantee more than 25 per cent. of heat from the refuse destructor for electric light purposes. But it was most gratifying to know that, instead of 25 per cent., they were getting 80 per cent. As an outcome of this agreeable surprise, they had—although they only started the works lately—been able to reduce the price of the electric lighting from 4½d. per unit to 3½d., and the town, as a whole, showed its appreciation of the fact by frequent application for extension of the supply.

London.—Last week the London School Board accepted a tender of £267 for supplying the necessary fittings for an electric light installation at the Upper Kennington Lane Schools. The Board agreed to negotiate with the South London Electric Lighting Corporation for the supply of current.

At last week's meeting of the Corporation Mr. Brooke-Hitching proposed that it be referred to a committee to approach the City of London Electric Lighting Company with a view to ascertain the price and terms upon which the company would be prepared to sell their undertaking to the Corporation. He believed it was impossible for a competitive supply to be allowed in the City. The resolution was rejected by a large majority.

Macclesfield.—At a recent meeting of the Gas Committee, Councillor Walker referred to charges which had been made that the committee were apathetic in regard to electric lighting. Personally he thought that the time was not opportune for the Corporation to take up the matter, but they ought to discuss it. Ultimately it was decided to debate the matter at the May meeting of the Council, the gas engineer in the meantime to collect statistics.

Marylebone.—On the 23rd inst. the Vestry resolved, on the Electric Lighting Committee's recommendation, to withdraw its Electric Lighting Bill.

Mill Lighting.—The electric light has just been installed at Cressbrook Cotton Mills, near Bakewell.

Montrose.—Last week the Council approved of the clause of proposed articles of association of the Angus Electric Light Company, Limited, regarding the appointment of *ex officio* directors.

Paddington.—The Vestry have received a letter from the Board of Trade, stating that the Metropolitan Electric Supply Company have appealed to them under Section 14 (c) of their order relating to Paddington, 1890, in respect of the disapproval by the Vestry of Paddington of certain works proposed to be executed by the company under the order, and the Metropolitan Supply Company Act, 1898, and that the Board of Trade have appointed Major Philip Cardew, R.E., to inquire into the matter of the appeal.

Penzance.—The Electrical Power Distribution Company has written to the Town Council asking if that body is prepared to consider the proposal for lease of powers to the company. The letter set out some notes in regard to terms of arrangement, and the Council passed it on to committee to consider.

Perth.—The Police Commission have received Mr. Hawtayne's report on the offers for the electric lighting of the city. It is stated locally that the report, which is now being printed, says that of the Messrs. Edmundson's would be the most advantageous to the city, but, as before, Mr. Hawtayne gives it as his opinion that the town would do better to take the electric lighting into its own hands.

Poplar.—The Guardians have referred the tenders for the electric lighting plant and artesian wells to committee.

Pretoria.—A contemporary says that £1,000 has been voted for the lighting of the Government Building strong rooms at Pretoria by electricity. The current will be supplied from the installation at the State printing works.

Rhyl.—It is recommended by committee that a field near Victoria Road be purchased as a site for electricity works, dust destructor, and workmen's dwellings.

Ross.—A firm having written to the Parish Council to announce their intention to apply for a provisional order to light the rural and urban parishes of Ross, the matter has been left for the new Council to consider at its first meeting on April 28th.

Shoreditch.—With respect to an offer of the County of London and Brush Company to pay £100 per annum for the privilege of laying two electric cables through the parish for conveying current from their station in City Road to other districts, the Shoreditch Vestry has agreed to this if the company will give an undertaking not to supply current in Shoreditch.

The Vestry is considering a proposal by Messrs. Wertheimer, Lea and Co., who are taking large premises in Shoreditch, and want to equip them for electric power. The firm wants to enter into an agreement with the Vestry for the supply of current for power purposes over a period of 21 years. The Lighting Committee has recommended the Vestry to agree, especially as it would be for current used mainly during the hours of the day. The matter comes again before the Vestry's next meeting.

Sydney.—Mr. G. W. Lacey, of London, recently submitted to the Sydney City Council a report upon the question of electric lighting. He advised municipalisation, and pointed out the advantages accruing from the adoption of electricity for traction. For Sydney he advises a direct current three-wire supply with 440 volts across the outers for lighting. He estimates the expenditure at £82,950, made up as follows:—Buildings, inclusive of overhead traveller, £8,000; station plant, including boilers, steam and exhaust piping, foundations, engines, dynamos, accumulators, switchboard, balancing gear, &c., £30,000; feeders, distributing mains, house connections, meters, system of street lighting by 520 arc lamps, inclusive of posts, mains, switch gear, and erection, £41,000; contingencies (5 per cent.), £3,950. The total receipts on the second year's working he estimated at £26,150, and the number of lamps connected at the end of the year he put down at 50,000, the number of public arc lamps at 520, and the estimated units sold to consumers at 720,000. The receipts for current from private consumers he estimated at £18,000, the receipts from public lighting at £7,800, and the meter rents at £350. Against this the estimated cost was £17,280, or a profit of £8,870 on the second year's working.

Ventnor.—The Ventnor Electric Light and Power Company, Limited, made a beginning on Saturday, when they turned the current on to the Royal Marine Hotel. It has been hoped that the esplanade lamps may be lighted by Easter.

Walker and Wallsend.—When the Walker and Wallsend Union Gas (Electric Lighting) Bill came on for second reading in the Commons last week, Mr. Hedderwick moved its rejection on the ground that the company promoting it were seeking to do that which the local authority was itself prepared to do—namely, supply the inhabitants within its own area with the electric light. No seconder being found for the amendment, the second reading was passed.

Warrington.—The Corporation has obtained an estimate showing that to fit up the new infirmary with 275 electric lamps would cost £300. The Corporation would carry out the work for the Guardians, charging the actual cost, and put down an engine and dynamo, and give a supply of light at 5d. per unit, which is below what will be charged when the municipal plant is running.

Windsor.—The electric light has now been switched on for street lighting, 10 2,000-C.P. and seven 500 C.P. arcs, and a large number of incandescents being employed.

Woking.—After a long debate the Council last week decided not to purchase the undertaking of the Woking Electric Supply Company. The resolution for purchase was only defeated by the casting vote of the chairman. A letter had been received from Edmundsons' Electricity Corporation, Limited, offering to

reconstruct the undertaking in accordance with Mr. Trentham's scheme, and work it for 14 years, guaranteeing the Council the sum required for interest and sinking fund.

Wolverhampton.—The work of excavation in connection with the extension of the electricity works has been commenced. The engine house and boiler house is to be extended 45 feet at a cost of £1,424. The boiler house now contains four boilers, and two new ones are to be put in, leaving space for two more. Two new engines are also to be added. The contract has to be completed by the middle of May.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Baker Street and Waterloo Railway Bill.—Sir G. Fardell had given notice to move the rejection of the above Bill. The Vestry of Paddington had petitioned against the power proposed to be taken by the company to erect a generating station at Paddington, and to take land for a terminal station and yard. Sir G. Fardell, however, told the House of Commons the other day that since his notice appeared on the paper, he had been approached on behalf of the promoters, who had suggested that if he would withdraw his opposition to the second reading, they would be prepared to say the generating station should be struck out of the Bill. He had replied that his constituents would withdraw their opposition if the company would be content to stop at Paddington station, which would thus give them a through route from Waterloo to Paddington. He said he would not move the rejection of the Bill, but he desired to enter his protest against some of its proposals, which he should oppose in every possible way. The Bill was read a second time.

Bangor and Donaghadee.—On 20th inst. Mr. J. H. Ryan, C.E., held an inquiry, on behalf of the Office of Public Works, in Bangor Courthouse, concerning the merits of the Bangor and Donaghadee electric tramway from an engineering point of view. Dr. Todd, solicitor to the promoters, said that the power station would be near to the centre of the line, and so far as he knew at present it would be not far from Groomsport. Mr. Plummer, C.E., engineer to the promoters, was examined as to the plan of the proposed tramlines. In the course of his examination it transpired that the system would be the overhead trolley system, with ornamental posts for town and plain posts for the country; that the gauge would be 3 feet 6 inches, the weight of rails 70 lbs.; that the lines through Bangor would be laid with concrete and paved with setts; that there are to be eight bogie cars, which will be lighted and heated with electricity. The generating station will be somewhere near Groomsport.

Bath.—The joint committee which has the matter in hand, proposes to inform the Drake & Gorham Electric Power and Traction Company, Limited, that the local authority itself proposed to apply for powers under the Light Railways Act. The routes suggested are—(1) From the Old Bridge to Devonshire Buildings; (2) Upper and Lower Weston; (3) Twerton and Batheaston. Mr. Metzger and the surveyor are to prepare plans of the routes, and, having already considered the cost, working, &c., of electric trams in other towns, they are to obtain full particulars of the approximate cost of laying electric tramways, together with all accessories.

Blackburn.—On Wednesday, 29th inst., the new municipal electrical tramways, which were described in our last issue, were publicly inaugurated.

Bradford.—The Tramways Committee recommends that the salary of the manager of the electric tramways be increased from £150 to £200 per annum.

Brighton.—It is stated that the scheme of electric tramways which the Corporation are now contemplating, will probably include a section bringing the Queen's Park and Zoo into close touch with all parts of Brighton.

Cardiff.—On Friday, at a meeting of the Cardiff Tramways Committee, Alderman Carey called attention to the fact that the Corporation would be taking over the tramways at the end of 1901, and that the committee would have to decide whether they would have separate generating stations, or make arrangements to get power from the present electric stations. Leeds had separate stations for their lighting and tramways, and Liverpool had successfully run the two from the same station. In discussion, it was remarked by the chairman (Councillor Andrews) that the Electric Lighting Committee would not be likely to supply the current. It was finally resolved that the chairman and the borough engineer do visit certain towns and report upon certain necessary points.

Clontarf.—The Board of Trade has written to the Council stating that the limit of speed of the electric trams is 10 miles an hour, but that it would be impracticable to run at this speed if the governors were set to act as soon as it had been attained; a margin was therefore allowed.

Greenock.—The Police Board last week considered the report of the deputation to London on the Tramways Bill. The amended proposals of the Tramway Company then put forward were that the rent payable by the company be £1,050 per annum instead of £750; instead of guaranteeing to take a minimum of 200,000 units per annum the company guarantee to take a minimum of 500,000 per annum, the rates to be as follows:—For the first 200,000 units per annum at 1½d. per unit, for the next 100,000 1½d. per unit, for the next 100,000 1¼d. per unit, and for any further supply 1d. per unit. The company will arrange breaks in the lease at 14 and 21 years to enable the Board to acquire the tramways within the burgh upon paying the company the full value of the undertaking as a going concern, having regard to the present value of the lines now owned by the Board; the company will undertake not to put up a generating station for the purpose of supplying currents to the tramways, so long as the Board will give a sufficient and satisfactory supply at the charges herein mentioned. New and better terms were also submitted by Mr. Murphy for acquiring the tramways, and this proposal came before the Board at the same time.

Houghton-le-Spring and Sunderland.—The local press contains details furnished by the promoters of this electric tramway scheme. A preliminary survey of the district has been made by the joint consulting engineers, viz, Messrs. Handcock and Dykes, electrical engineers, and Messrs. D. Balfour & Son, civil engineers. Altogether the scheme embraces fully 16 miles of tramways, and a present population of almost 60,000, over a busy industrial and rapidly extending district. The overhead trolley system and a 4 feet 8½ inches standard gauge will be adopted throughout. The passenger cars will be electrically heated and lighted. The local authorities affected are:—Houghton-le-Spring Urban District Council, Houghton-le-Spring Rural District Council, Hetton-le-Hole Urban District Council, Essington Rural District Council, and Sunderland Rural District Council, all of whom are being appealed to for sanction.

Litherland.—The Liverpool Electric Power and Lighting Committee have passed a resolution approving of the proposal of the Bootle Corporation to obtain power to supply electrical energy for working tramways in Litherland, by agreement with the Liverpool Corporation.

London.—The Light Railway Commissioners on Tuesday refused assent to a scheme for a Finchley, Hendon and district light railway, but approved of one for an electric railway from Hampstead through Finchley to Edgware. Consideration of a scheme for a line connecting Highgate, Finchley and Wood Green was reserved.

On Monday last week Mr. Clifton Robinson, jun., broke ground for the construction of the London United Tramways Company's new line. Work was commenced in Kew Bridge Road. It is stated that orders have been placed for all the necessary construction materials for the whole system, including the line from Hanwell to Uxbridge.

Lucan-Leixlip.—On 23rd inst. Mr. J. H. Ryan, C.E., on behalf of the Commissioners of Public Works, held an inquiry at Lucan, *re* a proposed electric tramway from Lucan to Leixlip. Mr. W. F. Clarke, C.E., on behalf of the promoters, stated that the new line was to be laid on the North side of the public road, adjacent to the footpath, from Lucan to where the road branches off to Celbridge. The line will there cross the Leixlip road and be laid on the South side of the road, from thence to Leixlip. The rails will be laid at the gauge of 3 feet 6 inches, on a raised platform, the height of the surface of the rail not to exceed a foot above the line of the carriage way. The line was to be constructed of steel girder rails, 50 lbs. per yard, on transverse sleepers. At road crossings grooved steel girder rails would be substituted, and would be laid at the level of the road. The total cost of construction for the adoption of electricity, &c., would be £4,950. The motive power would be supplied by the Dublin and Lucan Company. The inspector will report to the Board of Works as to the merits of the scheme.

Manchester.—On Wednesday last week a meeting of the committee which has been formed to investigate the proposal to construct an electric express railway between Manchester and Liverpool, was held at the Manchester Town Hall, under the presidency of the Lord Mayor, Mr. W. H. Vawdrey. On the motion of the Lord Mayor of Liverpool, a sub-committee consisting of representatives of commercial houses in both cities was formed. The Electricity Committee of the Manchester Corporation have received the sanction of the Board of Trade to their proposal to supply electrical energy to the districts of Levenshulme, Moss Side and Withington. The Drake and Gorham Electric Traction Syndicate, Limited, have written the Barton Rural District Council for authority to construct a light electric railway through Clifton, but the necessary sanction was withheld until the reply of the Lancashire County Council had been received.

Southampton.—Mr. Manville recently submitted a report and estimate to the Electric Lighting Committee in regard to the plant, buildings and feeders requisite for the supply of electrical energy to the tramways, and the cost of extending the electric light mains to the district of Shirley; also the cost of completing the range of boilers in the boiler house by the addition of two new boilers, and the further extension of the lighting mains to the Isolation Hospital, near Shirley, so as to provide for the installation in that building of 400 lamps of 8-C.P., besides those provided for in other estimates for consumers in Shirley. The addition of the two new boilers was necessitated in consequence of the increasing demand on the station for light, and the further demand that would be experienced in connection with the supply to the tramways. In connection with the buildings required for the battery, accumulators, boosters and switchboards for the tramway supply, the engineers have had before them the plan prepared by Messrs. Lemon and Blizard of the stables adjoining. The accumulator house would be of sufficient size, and so arranged as to enable the supply to the tramways to be doubled in the future; that was to say, they were assuming that the supply at present would require to be for 20 cars, and might in the future be extended to 40. The committee having

conferred with Mr. Manville, and fully discussed and considered the estimate of the expenditure proposed, resolved to recommend the Council to adopt the report and estimates and to apply to the Local Government Board for sanction to borrow the sum of £17,159 accordingly. Dr. Lauder remarked that the Council had bungled by putting such important works at the Back-of-the-Walls, and they were now commencing the patchwork. The method which the committee were adopting was the wrong one. The works were originally intended for lighting the town. They had engines of 1,200 H.P. there, and were now working to the extent of 900 H P. Where would they be at the end of 12 months at the rate they were going on? They would not have more than sufficient power for the lighting of the town alone. He objected to the proposed expenditure as a waste of money. By working their engines day and night they would reduce the life of the machinery by a half, and £10,000 was a great deal too much to spend on accumulators which in seven or eight years would not be worth a snap of the fingers. He moved that the clause be referred back to the committee, who should bring up a complete report on the plant necessary for supplying electricity to the town, both for lighting and motive power.—Mr. McDonnell seconded. He remarked that last year that time he was told that the committee had only expended half their capital, but now they proposed to go to the Local Government Board for power to borrow more money. He fancied that the deputy-chairman of the Tramways Committee never did a more foolish thing than when he voted for the purchase of the additional land at the Back-of-the-Walls, for the day would come when he (Mr. Dunsford) would ask the Council to give the Tramways Committee their own electric plant to drive their own cars. That was his (the speaker's) conviction, and the way in which the Electric Lighting Committee were going on seemed to show that they were approaching not only the full extent of their borrowing powers, but also the extent of their ability as regards production. Mr. McDonnell asked that the annual statement of the Electric Lighting Committee should be presented before the Council were asked to decide on the recommendation now before them. Senior-Bailiff Dunsford said the tramways deputation had come back with the feeling that eventually they would want their own electric plant. He thought their report conveyed as much; at any rate they had found that direct working was the cheapest and most successful plan for tramways. At the same time he thought the Council had done right in deciding to purchase the piece of land at the Back-of-the-Walls, as it would certainly be needed whether the Tramways Committee had a separate plant or not. From the experience and information which the deputation had obtained they found that where the electric trams were most successful they were worked quite separately from the electric light works. He suggested that the report should be referred to a joint committee of the Electric Lighting and Tramways Committees, and this was agreed to.

Sunderland.—Last week the Tramways Committee considered what style of car they would adopt when the tramways are taken over. The electrical engineer is to obtain prices of single and double-decked cars of different styles.

Western Australia.—The ceremony of turning the first sod in the construction of the scheme of electric tramways for Perth was performed in February by Miss Forrest, daughter of the Mayor, in the presence of a large gathering. The Tramway Company, under its arrangement with the City Council, is required to complete about 13 miles of line within two years and four miles within another five years.

TELEGRAPH AND TELEPHONE NOTES.

Brussels Telephone Service Disorganised.—It is stated that a heavy fall of snow took place in Brussels and the surrounding district on Monday, with the result that the service will not be repaired within a month.

The London Telephone Area.—It was stated by Mr. Hanbury last week that the London area under the Telephone Bill will be the area defined in Part 1 of the second schedule of the agreement of 1896 with the National Telephone Company, which was printed in Parliamentary Paper No. 128 of last session. It includes, among other places, the municipal boroughs of Richmond and Kingston-on-Thames, and the urban district of Surbiton.

The Telephone Service.—The Bristol Chamber of Commerce has passed a resolution regarding the Government telephone proposals to the effect that they are unsatisfactory upon the following grounds:—"(1) That the proposals do not meet the requirements of commerce, and are calculated to prove highly detrimental thereto. (2) That they would result in a multiplicity of systems organised by local authorities, which probably would be found afterwards difficult to unite. (3) That the working in detail of the telephones would be vexatious; and (4) that the Council of this Chamber regrets that apparently no weight was attached to the recommendations made to H.M. Government by numerous public bodies to the effect that one central authority was necessary for the satisfactory working of the telephones of the country."

West India Cables.—The *Standard* Washington correspondent says that the Attorney-General, Mr. Griggs, has rejected the application of the Commercial Company for permission to lay cables to Cuba and Porto Rico. The existing monopoly of West India telegraphs is thus maintained. Mr. Griggs arrives at this conclusion without considering the plea that the franchise under the Spanish grant of 1867 is exclusive of other companies, and he waives all distinction between Cuba and Porto Rico by classing them together as under administration by the executive as a measure of war, and as under the Declaration by Congress against the allowance of any interim concession. The power of Congress to control the executive is doubted; but since both agree upon the policy at issue, it is contended by the Attorney-General that it is clearly inexpedient to grant the application.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—The Corporation wants tenders for two Babcock boilers, one 180-kw. steam dynamo, and one 75-kw. balancing set. See our "Official Notices" March 17th.

Belfast.—April 20th. The Electric Committee want tenders for mechanical stokers, economisers, pipe work and condensing plant. See our "Official Notices" this week.

Blackheath and Greenwich.—April 6th. The Blackheath and Greenwich District Electric Light Company is inviting tenders for the wiring of 3,000 lights in 500 installations of 6 lights each. See our "Official Notices" this week.

Bradford.—April 12th. The Corporation want tenders for a complete battery and switchboard for the electric light station. See "Official Notices" this week.

Bristol.—April 10th. The Electrical Committee want tenders for high tension switchboards, instruments, &c. See "Official Notices" this week.

Edinburgh.—April 3rd. The Corporation want tenders for water-tube boilers. See "Official Notices" March 17th.

Edinburgh.—April 10th. The Corporation wants tenders for the electric lighting of the City Chambers. See "Official Notices" March 24th.

Leeds.—April 8th. Tenders for the electric lighting of the new dead meat market and abbatoir now erecting in New York Street are to be lodged with the acting town clerk (Mr. C. C. Jolliffe) by the above date. Particulars, plans, &c, from Messrs. W. Hanstock and Son, architects, Branch Road, Batley.

Peterborough.—April 20th. The Corporation wants tenders for Lancashire boiler, steam dynamos, balancers and boosters, switchboard, battery, piping, cables, &c.

Poplar.—April 25th. The Board of Works wants tenders for engine and boiler house plant, battery equipment and street lighting. See "Official Notices" March 17th.

Rochdale.—April 12th. The Guardians want tenders for an electric light installation at the Workhouse buildings and cottage homes. See our "Official Notices" March 24th.

Southend-on-Sea.—April 6th. The Corporation wants tenders for the "temporary" transfer of their 1891 Electric Lighting Order. See "Official Notices" March 3rd.

Spain.—April 20th. The municipal authorities of Santiago are inviting tenders for the supply and erection of the plant for a central power station to be erected near the town to utilise the water-power of the River Tambre for the generation of electrical energy for lighting and power purposes. Particulars may be obtained from, and tenders are to be sent to, El Presidenté del Consejo de Administracion Santiago, Spain.

Sutton and Howth (Ireland).—April 20th. The Great Northern Railway Company wants tenders for works in connection with their line between Sutton and Howth, near Dublin, including the supply and laying of feeders, returns, &c., rolling stock, overhead construction, battery and booster, &c. See our "Official Notices" March 24th.

Tynemouth.—The Corporation wants tenders for boilers, economisers, condensers, pumps, pipe work, water cooler, crane, switchboards, accumulators, cables, and traction steam dynamo. See our "Official Notices" March 17th.

West Ham.—April 21st. The Council want tenders for two 1,500-I.H.P. engines, and two 800-kw. alternators and exciters, or two 800-kw. 1,500-I.H.P. steam alternators and exciters. See our "Official Notices" this week.

West Hartlepool.—April 15th. The Corporation invites offers from those prepared to undertake free wiring of premises. See our "Official Notices" this week.

CLOSED.

France.—The French Post and Telegraph authorities in Paris opened tenders on the 16th inst. for the supply of a large quantity of wire. The result of the adjudication is as follows:—Messrs. Lazare Weiller & Co, of Paris, 50 tons of bronze wire, $1\frac{1}{10}$ mm. diameter, at 283 francs per metrical ton, 200 tons of copper wire, $2\frac{1}{2}$ mm. diameter at 235 francs, and 15 tons of copper wire, 1 mm. diameter at 233 francs; La Société des Etablissements

Mouchel, 5, Rue Boudreau, Paris, 50 tons of bronze wire $1\frac{1}{10}$ mm. diameter, at 281 francs 35 cents, and 50 tons of copper wire, $2\frac{1}{2}$ mm. diameter, at 233 francs 95 cents; M. A. Mouton, 44, Rue Amelot, Paris, 50 tons copper wire, $2\frac{1}{2}$ mm. diameter, at 208 francs 45 cents, and 50 tons ditto, at 207 francs; M. Grammont, of Pont-de-Cherny (Isère), 50 tons of copper wire, 2 mm. diameter, at 235 francs; Les Forges de Franche Comté of Besancon, 50 tons of copper wire $2\frac{1}{2}$ mm. diameter, at 235 francs; La Compagnie Francaise des Metaux, 10, Rue Volney, Paris, 100 tons of copper wire, 5 mm. diameter, at $234\frac{1}{2}$ francs; and La Compagnie Francaise du Bi-Metal, 9, Rue Dieu, Paris, 50 tons of copper wire, $2\frac{1}{2}$ mm. diameter, at $234\frac{1}{2}$ francs.

Middlesbrough.—It is stated that Messrs. Davy Bros., of Sheffield, have secured the contract for electrical plant for Middlesbrough. The amount of the contract is £7,000 and includes a set of 500 I.H.P. three-cylinder triple expansion engines, together with smaller engines to drive auxiliary dynamos. The electrical plant will be made for Messrs. Davy by Messrs. P. R. Jackson & Co.

West Hartlepool.—Last week the Council accepted the tender of Mr. Geo. Marshall, of Darlington, for the erection of the electric lighting station, at £11,473. The work is to be completed within eight months.

FORTHCOMING EVENT.

Friday, April 21st.—At 5 p.m. Physical Society. Agenda:—1. "On the Effect of a Solid Conducting Sphere in a Variable Magnetic Field on the Magnetic Induction at a Point Outside." By Mr. C. S. Whitehead, M.A. 2. "Demonstration of Richards's Method of Standardising Thermometers." By Mr. R. A. Lehfeldt, D.Sc.

NOTES.

Opening of New Tramcar Works.—A representative gathering of tramway officials and engineers was held at the Electric Railway and Tramway Carriage Works, Preston, on Thursday, 23rd inst., the occasion being the official opening of the works which will be the most completely equipped of their kind in this country. The buildings covering an area of 3 to 4 acres are well adapted in every way for the building of tramcars, &c. The company assembled about mid-day and spent some time in going over the works, after which they were entertained to luncheon, the chair being taken by Mr. George Richardson, the chairman of the company. The usual toasts of "The Queen" and "The Visitors" were proposed by the chairman, and "Success to the Preston Works" by the Mayor of Preston. Among those present were Dr. Edward Hopkinson, Mr. John Kerr, of Dick, Kerr & Co., Mr. J. B. Concannon, of the Dublin Tramways, &c., Mr. J. Turner, borough electrical engineer, Salford, and representatives from various Corporations interested in electric traction work. We understand that orders are now in hand and in process of completion for the North Metropolitan Tramway Company, for Bolton, Hull, and Liverpool Corporations, the Blackpool and Fleetwood, Potteries, and Dublin lines, also the Waterloo and City Railway. We wish the company every success in their undertaking.

What is a 75-H.P. Engine?—Mr. W. H. Wakeman asks in the *Engineer* (New York) what is a 75-H.P. engine. He answers himself practically by saying no one knows, for one man's idea is so different from that of another. The nominal horse-power has had its day, but we seem to be very little better off with the indicated horse-power, and with the I.H.P. we have got the B.H.P. and the E.H.P., and even the commercial H.P. As regards engine definition, we think that it would probably serve a good purpose to rate engines by a coefficient, which we would define as A.V., that is, the cylinder area multiplied by the piston speed in feet per minute or per second. If the former, we might divide by 33,000, when the coefficient would be the well-known figure used to find the H.P. for each pound of effective pressure. Simply to describe an engine as a 100-horse engine is unfair, if one man has in his mind an engine to expand four-fold, and the other intends to carry steam full stroke. Present in a Parliamentary Committee room we once heard a noted expert witness say: "There are five different kinds of horse-power. I have written a book on the subject, and I know all about it." Well, he may have done. Others don't profess so much, and it still remains difficult to properly and satisfactorily rate a steam engine.

The Advantages and Disadvantages of the Electrical Profession.—The *Electrical World* says that outside the profession it is generally thought that electrical occupations offer more brilliant opportunities and better pecuniary rewards than any other line of work. Hence the crowding of the technical schools with those who are preparing for electrical engineering, while thousands who cannot afford the school or college are straining to enter by other doors. A number of letters have been written to men of acknowledged reputation asking a series of questions, after the manner of Americans, as to the prospects and wages. It appears that draughtsmen secure an average of 9s. per day, up to an occasional 20s., but one man adds, "If you draw well, be sure you do other things well, or you may become a draughtsman for life." Mechanics may get from 20s. to 24s. per day, but hundreds in Chicago are slaving for 16s. to 36s. per week; but these are merely assembling parts. Isolated plant engineers get 48s. to 60s. per week. In special cases, as on telephone work, electricians get as much as 20s. a day. Armature winders average 10s. per day, their foreman 12s. to 16s. Wiremen receive 15s., but are lucky to be in work eight months of the year. Erecting electricians usually are graduates from their factory, and get £15 to £20 per month, but it is becoming common for the purchaser to erect, and fewer erectors are needed than formerly. Dynamo designers are credited with £15 to £20 per month. The lines of work offering the best future are indicated as water-power development, alternating current transmission, storage battery work, interurban railroad construction, electro-metallurgy, automobiles, and steam railroad conversion.

Personal.—On Saturday, 18th inst, Mr. Ch. Gerhardi was entertained to dinner at the Freemason's Tavern, Great Queen Street, by a host of submarine telegraph friends, in recognition of his recent decoration by the King of Spain with the Royal and Distinguished Order of Knight Commander of Isabel la Católica. Iltrmo Senor Don Nicasio E. Jauralde, the financial delegate for Spain in this country, presided, and, in a pleasing speech, paid a high tribute to the the services which Mr. Gehardi had been able to render to Spain in her time of need, in both his official and private capacities. Mr. Gerhardi replied in felicitous terms, expressing his gratitude to his old friends in the telegraphic service, and bringing back to memory some of his earliest experiences in connection therewith, reminiscences which must ever possess a charming interest for the veteran guest as he looks back over his 42 years of telegraph work.

The German Electrolytic Alkali Companies.—The Chem. Fabrik Greisheim, Elektron, and the El Chem. Werke, Bitterfeld, have arranged what our American cousins call "a deal," and in future the first-named company is to take complete control of the operations of the works at Frankfort, at Bitterfeld, and at Rheinfelden. It will also have charge of the sale of the products of these factories, with the exception of the sodium, magnesium, and calcium carbide, which are produced by the Bitterfeld Company alone. As regards division of profits, the Bitterfeld Company is to receive one-half of the gross profits made on the sales of the joint production of all the works, after deduction of management and technical supervision charges. The new works which these companies are building in France and Russia will, however, work independently, and will not be controlled by the joint organisation. Further details of the new arrangement will be found in the *Elektrotech. Zeitschrift* for December 22nd, 1898.

Lectures.—Prof. T. Preston lectured on the "Action of Magnetism on Light" at the University College, Dublin, on 23rd inst.

At Glasgow the other day Mr. Sam Mavor lectured on "The Electric Lighting of Interiors" before the Glasgow Architectural Association.

Mr. James Swinburne lectured at the Royal University Buildings, Dublin, on 24th inst., under the auspices of the Technical Education Committee, on the subject of "Electric Traction."

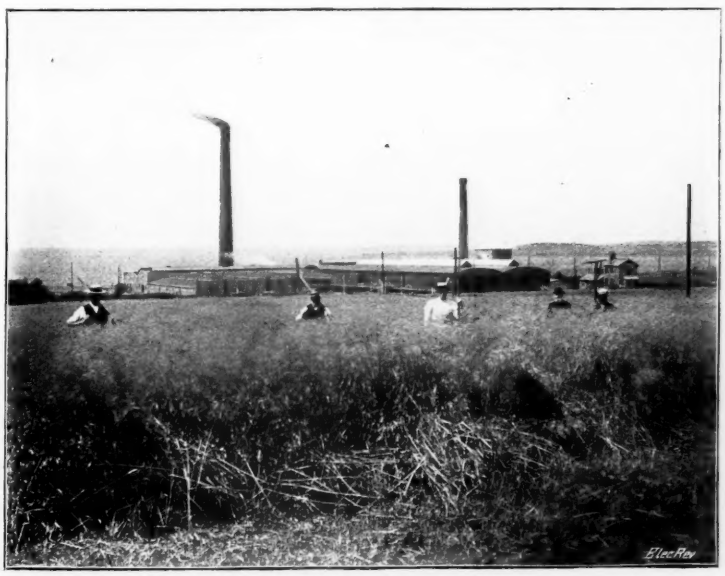
(*Continued on page* 514.)

THE CASTNER-KELLNER ALKALI WORKS AT WESTON POINT.

By JOHN B. C. KERSHAW, F.I.C.

The works of the Castner-Kellner Alkali Company at Weston Point, Runcorn, are interesting as indicative of the change which is taking place in one of the oldest manufacturing industries of our country—the alkali industry. In the year 1888 the late Dr. Hurter declared to the members of the Liverpool Section of the Society of Chemical Industry, that electrolytic processes of alkali manufacture could never be worked profitably on an industrial scale.*

So great was Dr. Hurter's reputation that the majority of those connected with the English alkali industry accepted this opinion as absolute fact, and one and all ceased to give much attention to the efforts of those foolish people who were trying to do what Dr. Hurter had declared was impossible. But Dr. Hurter had made the mistake of generalising from insufficient data; and though his deduction was perfectly correct as applied to his own conditions of experiment, it was no longer so when applied to other conditions of electrolytic decomposition. Only two years after this prophecy was uttered, it was proved to be valueless, for the Chemische Werke at Greisheim, near Frankfort, after lengthy experimental trials, commenced in 1890 to make caustic potash and bleaching powder by an electrolytic process, upon an industrial scale. Since that date, the electrolytic process for the manufacture of caustic alkalies and bleach has been adopted in many places, chiefly abroad; and had not the formation of the United Alkali Company in the year 1890 practically placed the English alkali industry entirely under Dr. Hurter's control, it is probable that there would have been a much greater extension of these new methods of manufacture in our own country. A study of the export and import returns for Germany and America as regards alkali and bleach in recent years, affords conclusive proof of the extent to which our country is losing ground as a producer of heavy chemicals; and though this decline of our export trade in alkali and bleach is not solely due to the adoption of electrolytic processes of manufacture abroad, this change is undoubtedly largely responsible for the increase of competition from Germany. In 1891 the exports of alkali from the United Kingdom amounted to 311,370 tons; in 1898 they had dropped to 188,556 tons. In 1891 our exports of bleach amounted to 75,685 tons, in 1898 they were only 56,184 tons.



Showing Outside View of Works, with Crop of Oats growing up to its Walls.

The erection of the large electrolytic alkali works of the Castner-Kellner Company, at Weston Point, Runcorn, close to the chief centre of the English alkali industry is, therefore, but another sign of the extent to which the older process of manufacture is being pressed by the new. A few miles away, at Widnes, are to be seen numerous examples of the old style of Le Blanc chemical works, with their huge acid chambers and towers, and their general appearance of dirt and dilapidation. The contrast between the old and the new is all the more striking at present because many of the Le Blanc works have been stopped in recent years; and a disused chemical works is, in the writer's opinion, a symbol of the very quintessence of ruin and decay. The electrolytic works, on the other hand, has all the advantage of new buildings and new paint, and, as shown in the figure, Dame Nature takes kindly to the new method of manufacture, and allows oats to grow within reach of its boundary walls. Whether oats will *continue* to grow there is, however, a matter of doubt. The electrolytic process, simple as it may be when compared with the older process of alkali manufacture, nevertheless, involves the liberation of chlorine as a gas; and chlorine, when once liberated, is very difficult to wholly re-absorb, and is apt to escape and injure the vegetation of the neighbourhood. But the suppression of pyrites kilns, of acid chambers, of salt cake furnaces, and of acid towers—all features of the Le Blanc works, and all contributors to the poisoning of the atmosphere with deleterious acid gases—is a distinct gain, and, judging the old and new processes of alkali manufacture, solely from the hygienic standpoint, there can be no doubt that the latter is the better of the two.

The two processes start with the same raw material, common salt, and are designed to effect the same ends, namely, the separation and conversion of the sodium into sodium hydrate, and of the chlorine into bleaching powder. In the electrolytic method of manufacture, one operation in the electrolytic cell produces a solution of caustic soda, and free chlorine. To obtain the same results by the Le Blanc process, a whole series of operations, and the production of several by-products, are necessary. Pyrites is burned in order to obtain sulphuric acid. This acid is used to convert sodium chloride into sodium sulphate (salt cake). The

* *Journal Society Chemical Industry*, 1888.

sodium sulphate is converted into sodium carbonate by roasting with coal and limestone. The sodium carbonate is then changed into hydrate by boiling with caustic lime. As regards the chlorine, three more operations are necessary in order to condense and decompose the hydrochloric acid gas, liberated when the salt and sulphuric acid are brought together; and one more by-product is obtained. The superiority of the electrolytic process over the older Le Blanc process, as regards simplicity, is therefore even more marked than its hygienic advantages.

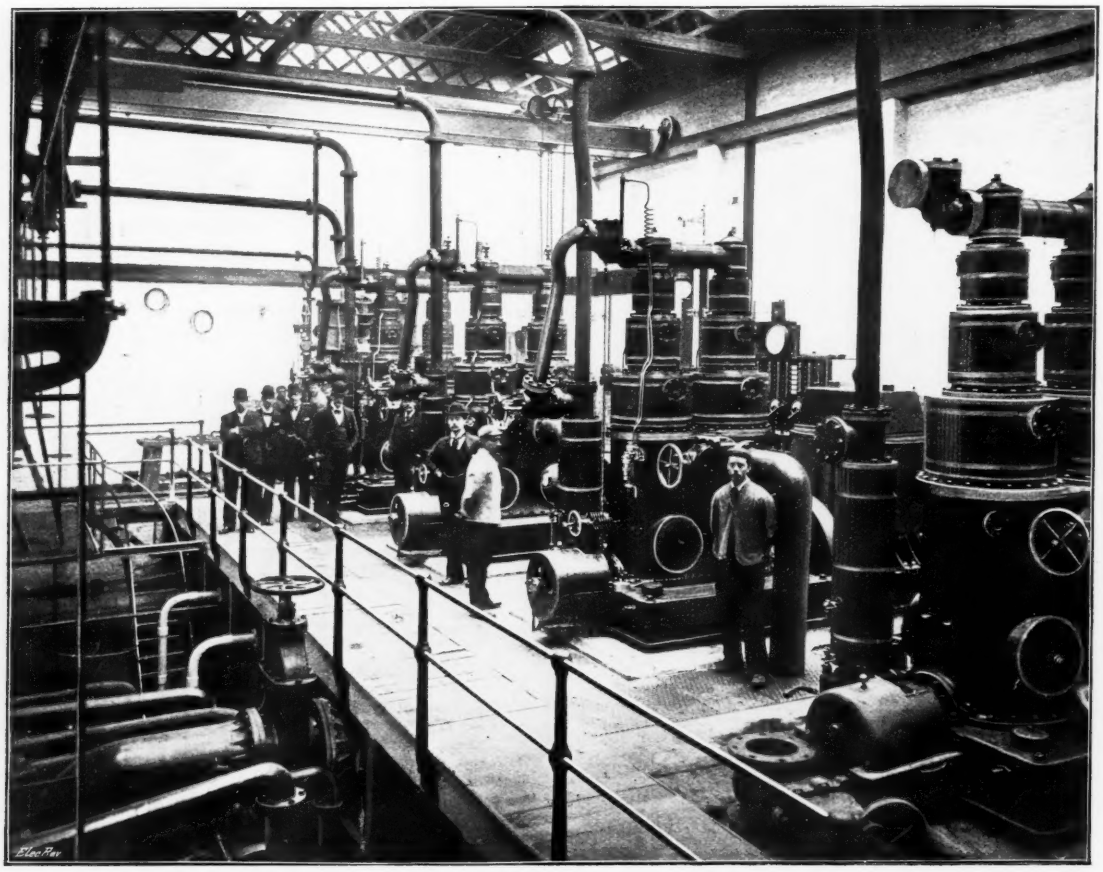
The Castner-Kellner process differs from the other electrolytic alkali processes that have received industrial trial, in the means taken to remove the sodium, liberated at the cathode, at once from the further action of the current. In the Hargreaves-Bird process a combined diaphragm cathode of peculiar construction is used, and the cathode compartment of the cell contains only steam and carbonic acid gas. In the Castner-Kellner process mercury is used as cathode material, and the sodium amalgam which forms is automatically removed at short intervals from the cathode compartment of the cell. In the Hulin process a somewhat similar effect is obtained by the use of fused salt as the electrolyte, and of molten lead as the cathode material.

The details of the Castner cell are as follows:—

A cell built up of slate is divided into three compartments by two partition walls, which dip into, but do not close, grooves in the bottom slab of the cell. The two end compartments are entirely closed; the centre one is open. The end compartments are supplied with a strong solution of common salt, or of potassium chloride; the centre one is fed with water. Mercury, sufficient in quantity to cover the bottom of the cell to a depth of $\frac{1}{8}$-inch, is then placed in the cell, and electrical connection is arranged between this layer of mercury and the negative terminals of a continuous current dynamo. The positive terminals of the same dynamo are connected with carbon or platinum anodes, suspended in the solution of chloride in the end compartments of the cell.

When the electrical connections are made, the sodium chloride is decomposed by the current passing from the carbons to the mercury. Chlorine is liberated in the anode chambers as a gas, and is carried away by suitable exhaust fans to the bleach chambers, while the sodium ions migrate towards the mercury, and unite with it to form a sodium-mercury alloy, or sodium amalgam.

Were no provision made for renewing the mercury surface, the crust of amalgam would soon completely cover it, and cause the voltage required per cell to increase rapidly. The amalgam is automatically moved into the centre compartment of the cell at short intervals by means of the device patented by Castner in 1893, and illustrated by figs. 1 and 2. The cells are all built and mounted in such a manner that, by means of the shaft, E, and eccentrics, F, they can be periodically subjected to a slight rocking movement of about $\frac{1}{4}$-inch. This suffices to mix the mercury and the amalgam, and to cause fresh supplies of the mixture to be continually brought into the centre compartment of the cell where it is decomposed by the water.



The Engine and Dynamo Room. Capacity, 1,000 H.P.

When the cell is horizontal as shown in fig. 1, both anode compartments are taking their share of the current supply, but as the motion of the eccentric continues, the cell slightly rises in front, and the mixture of mercury and amalgam flows by gravitation into the compartments A_2 and A_3. After a brief stay in this position, the revolution of the eccentrics brings the cell back again to the horizontal position, and then causes the cell to dip slightly in front. The mercury, freed from its sodium by contact with the water in A_2, now flows back into A_1, and its place is taken in A_2 by the mixture of mercury and amalgam from A_3. The anode compartments, A_1 and A_3, are thus alternately in action as decomposing chambers of the cell; while in A_2 there is a constant supply of mercury and amalgam ready for the action of the water. In actual operation of the process, some difficulties were at first encountered, due to the tendency of the chlorine to form Hg_2Cl_2 in the anode chambers of the cell, and to

the loss of mercury with the escaping hydrogen in the centre compartment of the cell. The writer is not aware how Mr. Castner has overcome the first difficulty; the second has, however, been surmounted by adopting a method suggested by Dr. Kellner in Patent 17,169, of 1892.

A grid-shaped electrode of iron is suspended in the water in A_2, and is placed in electrical contact with the mercury and amalgam lying on the bottom of the compartment. The couple acts as a primary element; the sodium of the amalgam combines with the water, and the hydrogen ions are set in migration towards the iron. The hydrogen gas which is thus liberated as a result of the chemical action,

$$Na + H_2O = Na\,OH + H,$$

is set free, not at the surface of the mercury, but at the grid-shaped iron electrode, and it escapes into the air without causing any loss of mercury. The E.M.F. created by the reaction is also rendered of practical value, and diminishes that actually required to decompose the solution of salt in the anode compartments of the cell.

The solution of sodium hydrate obtained in this manner is said to be absolutely free from chloride, and the further operations of boiling down, by which high strength caustic is obtained, are therefore considerably simplified.

Table I.—Current and Energy Efficiencies of the Various Wet Processes.

Process.	E.M.F. required.	Actual yield in grams.				Efficiencies per cent.	
		Per ampere-hour.		Per kw.-hour.			
	Volts.	Na OH.	Cl.	Na OH	Cl.	Current.	Energy.
Hargreaves-Bird	3·4	1·196	1·057	351	310	80	54
Castner-Kellner ...	4	1·363	1·136	340	284	91	52·3
Richardson and Holland.	6	...	...	...	...	97½	37·3
Ditto.	4	..	...	...	...	97½	56
Theoretical figures	2·3	1·495	1·322	650	574	100	100
Dry Processes.							
Hulin	7	1·052	907	150	129	69·3	41·5
Theoretical figures	4·2	1·495	1·322	356	314	100·0	100·0

The Cell Room. Capacity, 1,000 H.P.

Turning now to a consideration of efficiency and costs, the following table showing the comparative efficiencies of the three English electrolytic alkali processes, and of the Hulin process, is compiled from earlier articles by the writer on this subject.*

The following figures, as regards the Hargreaves-Bird process, are based on the average of 59 days' work at Farnworth. The Castner-Kellner figures are the results of seven days' work of the Castner cell at Oldbury; the Richardson and Holland figures are based on statements in Dr. Hopkinson's report; and the figures for the Hulin process are drawn from the reports of the experimental trials at Modane, in Savoy.

* *Electrician*, January 29th, 1897, and March 4th, 1898.

The 97½ per cent. current efficiency of the Richardson and Holland process is certainly not obtained in actual work, and the figures given to Dr. John Hopkinson were evidently merely estimates, and therefore unreliable.

The Castner patents were owned by the Aluminium Company, of Oldbury, and in October, 1895, this company entered into an agreement with Messrs. Solvay & Cie., of Brussels, who owned the Kellner patents relating to the use of mercury in electrolytic cells, whereby the interests of the two companies were safeguarded. Messrs. Solvay & Cie. assumed the ownership of the Castner-Kellner patents for Europe, while the Aluminium Company became owners of the combined patents for the United Kingdom, the British Colonies, and the United States of America. The English

rights were then sold by the Aluminium Company to the Castner-Kellner Alkali Company for £125,000.

The share capital of the latter company is £300,000, and £80,000 has recently been added to its capital account by the issue of debentures. The erection of the works at Weston Point was commenced in 1896, and in 1897 the first 1,000-H.P. installation was set in operation.

The results were satisfactory, and at the annual meeting of the company, held in London on May 27th, 1898, it was stated that the trading profits on the seven months' operation of the first unit of their plant had been £9,161. Some difficulties had been met with, however, due to impurities in the brine, and the second unit of plant, which has since been set in operation, is understood to be working upon potassium chloride, in place of sodium chloride. The erection of two more units of machinery and plant, making, in all, 4,000 H.P., was also at once put in hand; but writing on October 18th, 1898, the secretary informed the writer that these were still in progress. In October an interim dividend of 8 per cent. was declared for the half-year ending September 30th, 1898, so that this company appears to be firmly established, and to have proved that the electrolytic alkali manufacture can be made to pay even in this country.

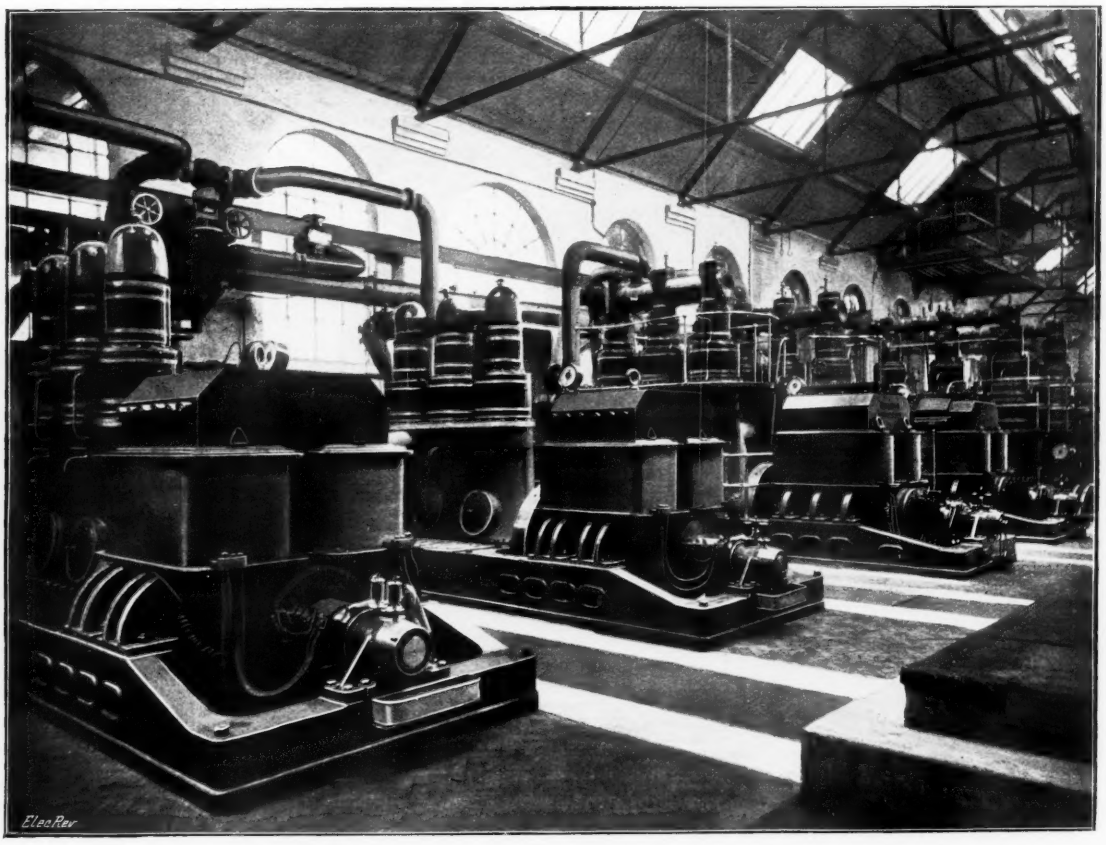
There have been no estimates published of the cost of alkali and bleach by the Castner-Kellner process; and in the absence of any data relating to the losses of mercury, and to the costs of repairs and renewals, it is difficult to form a reliable estimate of the cost per ton of alkali and bleach by this process. The following table is, however, interesting as showing the wide variations between the estimates of different authorities. The estimate made by the writer for the Castner-Kellner process is based on the output and the profits during the seven months ending March 31st, 1898, but no allowance has been made for depreciation or losses of mercury.

Estimated Cost of 1 Ton 70 per cent. Caustic Soda and 2·1 Tons 35 per cent. Bleach.

Process.	Cost.	Estimate made by
Richardson & Holland	£8 13 0	Leith.
Hargreaves-Bird	£8 11 0	Hargreaves.
Castner-Kellner	£9 16 0††	Kershaw.
General estimates for any electrolytic process.	£16 18 0	Cross & Bevan.
	£17 7 0	Hausermann.

† Of this total electrical energy accounts for £3 9s. 10d., taking the E.H.P.-hour at ½d.

The selling value of the above amounts of caustic soda and bleach, at current prices, is £15 10s., and the writer estimates that they can be produced by the Le Blanc process for £13.



A General View of Brighton Electricity Works. (See page 513.)

The Castner-Kellner Alkali Company is now obtaining a price for its bleach, 30s. per ton above the market value, for it has made an arrangement, under which the whole of its production until 1900, is to be taken by the Solvay firm of Brussels at £5 17s. 6d. per ton. At present it is, therefore, making a larger profit on this product than it can hope to make when the contract comes to an end.

The illustrations show the generating machinery and decomposing cells of the first 1,000 H.P. unit of plant at Weston Point. The engines are by Willans & Robinson, they are quick speed, and are coupled to direct current dynamos built by Mather & Platt. The engines are 250 I.H.P., the dynamos are 150 kw. machines, and each delivers 1,300—1,400 amperes at 110 volts.

For utilisation of this electrical energy 250 cells are provided. They are worked in series of 25 cells, each cell being estimated to require 4 volts. The cells are built of slate, and are 6 feet long × 3 feet broad × 6 inches deep.

In conclusion, it may be pointed out that, in comparing the costs of alkali and bleach by the various processes of manufacture, and in forecasting the prospects of the electrolytic processes, it is necessary to make allowance for the sums paid for patent rights. In the Le Blanc process of alkali manufacture, all the more important patents have lapsed, and the capital expenditure upon patents may be *supposed (!)* to have been written off years ago.

The electrolytic processes are, on the other hand, all hampered by the heavy expenditure under this head. The

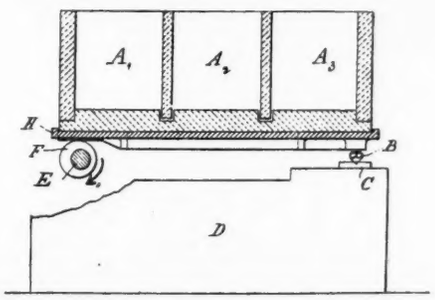


Fig. 1.

£125,000 paid by the Castner-Kellner Company to the Aluminium Company represents a standing charge of 38s. 5d. upon every 1 ton of caustic and 2·1 tons of bleach at present produced; and even when the output has reached the maximum of 6,300 tons caustic and 13,600 tons bleach per annum, this charge will still be one-half the above. The

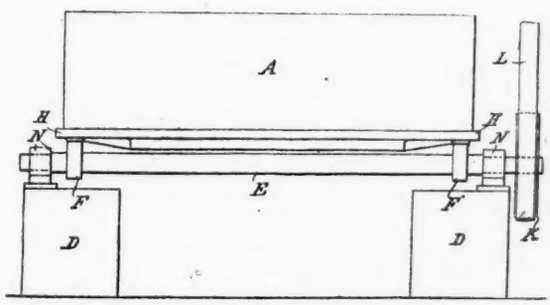


Fig. 2.

position of the electric processes in 10 or 12 years, when the patents have lapsed, will therefore be materially improved.

The writer's thanks are due to the Castner-Kellner Alkali Company for the excellent photographs which have been used for the illustration of this article. He regrets that the company has not been equally ready to supply facts and figures relating to their plant and output of soda and bleach, and for these the writer has been obliged to rely upon less trustworthy sources of information.

THE DEVELOPMENT OF BRIGHTON ELECTRICITY WORKS.

In dealing with the Brighton Corporation Electricity Works, we propose to direct our remarks mainly to the commercial development of the undertaking rather than to the engineering details of the system. It is not suggested that the technical side presents no points of interest, indeed, it is hardly likely that any electrical works could achieve a striking commercial success without evolving some mechanical and electrical features of more than ordinary importance.

It is almost superfluous to say that for the most part the system is a three-wire low tension, but some use is also made of alternating current for purposes which we will shortly indicate.

Up to a certain point the generation and distribution of electricity is a comparatively simple matter, but with increased output, the supply of electricity over wider areas and a greater lamp density in restricted districts, the problem becomes a little more complex. These are matters that affect the commercial side of a system quite as much as the engineering, and probably the great and conspicuous success achieved at Brighton is in a great measure due to the fact that the development has been treated from the commercial rather than the engineering standpoint.

The plant consists for the most part of bipolar machines, driven by Willans engines; but the most recent additions comprise multipolar dynamos direct coupled to Willans engines. The subjoined and subsequent illustrations will show the principal features of the works.

The following gives the sizes of the various units, the multipolar dynamos being the ones recently added:—

Willans engines.		Dynamos.
No.	I.H.P.	Kilowatts.
2	80	45
2	200	120
4	360	220
4	800	500 (multipolar)
Total I.H.P., 5,200		Total kw. capacity, 3,210

In order to keep the roof at the same level it was found to be necessary when adopting the large multipolar units to make the foundations of the plant lower than those for the older plant, and on this level the whole of the extensions will be carried out. A separate switchboard controls the multipolar plant, the chief features of the board being the use of plug switches and edgewise ammeters.

The exigencies of expansion have necessitated two boiler houses, the newer one being below the street level and containing a series of water-tube boilers of the Babcock-Wilcox type, while the original boiler house erected on the street level contains Lancashire boilers. Hand firing alone is employed; the coal for the water-tube boilers falls by gravity into bunkers on the boiler level and the ash is conveyed to the street level by an electrically worked hoist, it being obviously cheaper to raise the resultant ash than the original coal. Electric motors are used to a considerable extent for operating the auxiliary plant, though the boiler feed pumps are driven by steam engines; the importance of not relying wholly on electricity for operating auxiliary plant has been sufficiently demonstrated at Brighton. Water is taken from the street mains and costs 5d. per 1,000 gallons; it possesses, we believe, 24° of hardness, and to bring it to a usable condition a softening apparatus is employed, in which the water passes over lime and then over a layer of asbestos which takes the last remaining hardness out of it. It is interesting to observe that in the water tanks are placed resistances for providing a load for testing purposes; they consist merely of wire wound on wooden frames, but are capable of absorbing very heavy currents.

The method of carrying the mains from the switchboards to the streets is perhaps one of the most notable features of the works. On leaving the board the mains are carried to underground tunnels which traverse under the engine room floor and under the street adjoining the station, this arrangement permitting of the ready indentification of the feeders.

The condensing apparatus is of special design, and well worth describing. It consists of a Barnard-Wheeler water cooling tower of the twin type, and two surface condensers mounted directly on horizontal air and circulating pumps.

The tower has been erected on the roof of the engine house between the two bays, and is of a capacity for handling the circulating water sufficient for condensing 40,000 lbs. of steam, or the steam from engines of 2,000 I.H.P. The total floor space required is only 14 feet × 18 feet and the height 37 feet 6 inches, so that the tower is of a capacity equal to 8 I.H.P. to 1 square foot, a maximum result with a minimum space. The weight is so equally divided that no extra

provisions had to be made to strengthen the roof when the tower was erected.

The tower is in two sections, each 9 feet × 14 feet, and so arranged that either section may be operated singly or both together as may be desired, and the method of piping allows of this being effected to either of the condensers located in the basement some 40 feet below.

The shell of the tower is of steel plate reinforced with channel and angle irons and securely braced by cross pieces, the lower plates are only ¼ inch in diameter tapering to ⅛ inch at the top, the foundation piece consisting only of a good angle iron piece held down by foundation bolts let in the concrete in the roof.

The circulating water leaves the condensers at a high temperature, and is pumped to the top of the towers, where it is delivered into a cast-iron V-shaped trough. From the sides are fitted perforated and slotted pipes 1¼ inches in diameter, connected to the sides of the tower by gun-metal caps. From these pipes hanging vertically are mats of fine mesh wire spaced 3 inches apart, and so arranged as to allow of a clear passage of the air between them. The mats are woven of steel wire, and to ensure long life are galvanised after weaving.

From the pipes the hot water overflows on to the mats, down which it runs in thin sheets, the matting having a retarding effect on the speed of the descending water, thereby subjecting it fully to the cooling and evaporating effects of the air currents.

There are 86 mats, each 14 feet × 21 feet, giving more than 50,000 square feet of cooling surface.

The air is driven through the towers by means of four 8-feet Blackman air propellers, two to each section. These are belt driven, the power being supplied by two shunt wound motors, each of 18 I.H.P., and of the British Thomson-Houston make. The fan speed is 160 r.p.m.

An important feature in the construction of the towers is their simplicity of design. Any mat, or number of mats, may be removed for cleaning without interfering with the working of the apparatus, and the slotted pipes can be readily swabbed out by removing the external caps, a ladder and gallery being arranged around the upper part, and on a level with the caps, so that quick and easy access can be had to the pipes and the upper works.

After the process of cooling has been effected, the water falls into a reservoir, this forming the base of the apparatus, from whence it is drawn away by the circulating pumps.

These pumps are of the Blake & Knowles manufacture, and consist of horizontal compound steam cylinders, operating air and circulating cylinders on one common bed-plate, the condenser being directly mounted over the top of the above pumps. The dimensions of the pumps are as follows:—

7-inch high pressure steam cylinder.
14 „ low pressure steam cylinder.
16 „ air cylinder.
18 „ circulating cylinder.
all having 16 „ stroke.

The condenser being mounted on top allows the condensed steam to gravitate down into the air pump, always keeping the valves flooded, and obviating the necessity of any intermediate piping between condenser and pumps.

The normal speed of pumps is about 30 double strokes per minute while on full load.

The condensers are of the Wheeler standard pattern, arranged with double tubes, one tube arranged inside the other. The tubes are drawn thick at one end, and have a deep thread cut in the same. The tube is screwed into outer tube-plate; an inner plate is also provided, from which a larger tube is carried, the other end having a blank cap on same. The smaller tube is inserted in large tube, and as all the joints are screwed, the arrangements dispense entirely with any packing, forming a simple, effective, and absolutely tight jointing, allowing amply for the necessary expansion, and by the addition of central plate allows for the circulating water to pass four times through the condenser before finally being delivered to the top of the tower. The piping arrangements are simple, and the outfit works exceedingly satisfactorily. The temperature of the circulating water is reduced, so that a good vacuum may be carried.

The total amount of water lost by evaporation is exceedingly small. There is no atomisation to speak of; in fact, the location of the Brighton station would not permit of any scheme that would cause any complaint in this direction.

We understand that this outfit has given entire satisfaction, and that the Wheeler Condenser and Engineering Company are entrusted with the order for the extensions, namely, a complete condensing set of towers and condensers of a capacity to deal with 50,000 lbs. of steam.

(To be continued.)

NOTES.

(*Continued from page* 508.)

A New Primary Battery.—A young Frenchman has invented a primary cell which is said to give 13 amperes at 2 volts for a longer time than the ordinary bichromate cell or the Bunsen cell. Its essential characteristic is that a vanadium salt or vanadic acid is contained in the exciting fluid or in the substance of the negative or positive electrode. Such an element consists preferably of an external vessel containing a solution of 20 parts of Na Cl to 100 parts of water, in which an amalgamated zinc rod is dipped; an inner porous jar for the reception of a carbon plate, and which is filled with a mass of powdered manganese oxide and fused vanadic acid. This jar contains also a solution of sulphuric acid, vanadic acid, and hydrochloric acid. 10 per cent. of sulphuric acid may also be added to the Na Cl solution in the external vessel. The depolarisation is very energetic on account of the combined action of the hydrochloric acid, the oxygen, and the chlorine. Moreover, the reducing effect of the hydrogen is regulated by the presence of the vanadic acid, since this passes into hypovanadic acid, and is immediately again oxidised to vanadic acid by the hydrochloric acid, while the hydrochloric acid liberates an equivalent of chlorine and four equivalents of oxygen. An addition of 10 per cent. of bichromate of potash to the acidified solution increases the output. Special cells have been designed for application to motor cars.

Feed Water Heater.—An open type of exhaust feed water heater, described in the *Street Railway Journal*, consists of a vertical cylinder not unlike a vertical boiler. In its upper portion there is a series of seven trays supported loosely on a perforated central pipe. Water is admitted at the top through perforated pipes, and descends through the various trays, and finally falls in a shower to the body of water in the lower part of the cylinder. Steam (exhaust) is admitted at one side of the cylinder, and passes up between the trays and shell, and over the surface of each tray into the middle hollow pillar giving up its heat on the way to the boiler. The upper tray is perforated, the others allow the water to discharge over their edges on to the trays below. All the parts inside are of cast-iron. There is a trough to skim off oil and a further auxiliary suction vessel coupled to the bottom of the cylinder, its upper end being connected to the steam space of the heater, so that if the water level falls too far the pump will draw steam. This is to safeguard the boilers against a greasy feed. The usual blow-out and cleaning arrangements are fitted. Some of these heaters are as much as 20 feet in height and 5½ feet in diameter.

A Substitute for Galvanising Iron and Steel.—The *Journal of the Franklin Institute* says that Wilder's patented process for coating steel and iron consists in the use of a bath composed of zinc, tin, and aluminium. This mixture, it is claimed, produces a coating on iron and steel much superior to any now known, being so firmly adherent, that the sheets will stand working after it has been applied, will resist corrosion, and can be heated red hot without injury. The coating is applied by the same method as galvanising, *i.e.*, by dipping the cleansed sheets, &c., in the melted alloy. The most approved mixture is the following composition by weight:—Zinc, 84 per cent.; tin, 14 per cent.; lead, 1·5 per cent.; aluminium, 0·5 per cent.

Mr. Balfour on Technical Education.—Speaking at the opening of the Battersea Polytechnic, Mr. Balfour contrasted the past relation of science to industry with that which prevails to-day. He believed that neither by himself nor by others were any of the great Isaac Newton's discoveries turned to any practical account. Yet Newton set the whole world upon the right path in everything connected with energy by his discovery of the law of gravitation. Pasteur and Kelvin, two of the greatest names of the present age, have lived to see their discoveries put into almost immediate industrial use. All this is because to-day science and practice, which began far apart, have now approached these curves and become practically straight lines of parallel progress. Mr. Balfour looks on the social side of the polytechnic as affording somewhat of the influence of University life—the civilising and humanising influence which sheer technical training alone cannot give. As we have before said, the polytechnics ought to be better utilised by day and their social side could be developed in the evening hours. If the apprenticeship system is to pass away, the polytechnics will need multiplication and extension as purely trade schools, after the manner of the German trade schools. At present we spend far too much on the institute as a self-contained building. This cannot be continued; the trade school would require more practical and plain buildings—mere sheds, which, when out of date, could be replaced by others up to date. Over-substantiality has long been a fault of English industrial buildings. Too solid and expensive, they become a hindrance to improvement. The excuse for unnecessary solidity disappears with electrical driving, which requires no wall support for shafting. Mr. Balfour made a special call for thoroughness, while pointing out that in all countries only the few students could be expected to leave a school fully abreast of their subject to date. His advice to students is to be thorough in what they acquire. To acquire a knowledge of general principles without a knowledge of details is not superficiality if the general principles are well learned. One may know little without being superficial—a good deal, and yet be very superficial. He characterised thoroughness or superficialness not as qualities of the knowledge acquired, but of the acquirer.

Telegraphy by Ultra-Violet Light.—Zickler sometime ago succeeded in transmitting signals over a distance of two or three hundred yards by taking advantage of the property of ultra-violet light which facilitates a spark discharge over an air gap. Dussaud has now succeeded in transmitting sounds and even words by the ultra-violet rays. The rays are made to act by means of a fluorescent screen on a plate of selenium, and the vibrating membrane of the transmitter is so arranged that while vibrating it cuts off varying amounts of the rays. The action on the selenium and the current which flows through it varies, just as it varies in an ordinary telephone. An ordinary telephone is used as a receiver in Dussaud's apparatus; but the distance over which messages have been transmitted is only a few yards.

Electric Fish.—Last Friday week, before the Royal Institution, Prof. Francis Gotch, F.R.S., discoursed on the "Electric Fish of the Nile." After commenting on the biological difficulties in the way of conceiving the conditions that could ever have determined the evolution of the electric organ, he described it as consisting of a pile of compartments each enclosing a plate or disc in albumenised jelly. In the Nile fish there were some two millions of these. As to the absolute seat of the electrical charges, says the *Times* report, he personally believed it to be the nerves, and if it was objected that this theory left no function for the expanded discs, he could conceive of several ways in which they could contribute to the electrical effect. In tissue from a quite recently killed fish one stimulus of the nerve gave not one discharge, but a large number in succession. The discharge was from the head to the tail, and took a distinct time—about one-thousandth of a second—to culminate. The fish was able to regulate it, possessing to that end a unique sort of central nervous system, but it could not send the nerve stimulus more than 10 or 12 times a second, and could not go on at that rate for more than six times, owing to fatigue of the central system. As to the use of this organ, the Nile fish was very pugnacious. With his own kind his mouth was his chief weapon, for his foe must be supposed to enjoy a relative immunity from injury by electric shock. Small fish of other kinds he attacked both by his mouth and his electric organ, but it did not seem probable that he gained his food in this way, because of the profound exhaustion that would be the price of a meal. Since he usually lay in the mud, it was certain that he fed on much smaller forms of life. As a means of defence, the utility of the electric organ must be enormous, and no large fish was likely to make the mistake of tackling him twice. In conclusion, Prof. Gotch said he thought this fish had really a higher intelligence than was usually attributed to the fishy kind, and told a story of how one, kept in captivity with a roach, obtained all his food in a half-digested condition at the expense of his companion by a judicious use of his electric organ. Two living specimens were exhibited.

The Pulverisation of Incandescent Platinum Wires.—We know that platinum wires, rendered incandescent in a bulb almost exhausted of air, project on to the sides of the bulb particles of their substance, which arrange themselves in a straight line, and form a thin frame, enclosing the obstacles encountered between the wire and the glass. A similar phenomenon takes places with the carbon filaments of incandescence, and the study of it may have a certain interest from the point of view of the construction of these lamps. Mr. W. Stewart has just subjected the phenomenon to a fresh investigation, the principal results of which are as follows:—When the wires are brought to incandescence in the air by atmospheric pressure, the pulverisation diminishes in intensity as the incandescence is prolonged. The humidity of the air has no influence on the phenomenon. The pulverisation diminishes with the pressure. For platinum, it is reduced by two-thirds in passing from the pressure of the atmosphere to that of 1·25 mm. In nitrogen and hydrogen, the pulverisation is insignificant. In oxygen, on the other hand, it is excessive. In short, Mr. Stewart's experiments confirm the views before expressed by Mr. Nahrwold, according to whom, the oxygen was the sole cause of the pulverisation of incandescent platinum. If this is the case with carbon, it would be advisable, when exhausting the lamps, to introduce an inert gas, which, as it was drawn out, would carry off the last traces of oxygen.—C. E. G (*L'Industrie Electrique.*)

Sheffield Smoke.—Sheffield on a dark evening has much that looks bright and brilliant, but in the daylight, grime is a prevailing feature. But it is healthy sort of grime and has no serious effect upon the near country, unlike the copper fumes of Swansea. The great proportion of Sheffield smoke comes from furnaces, which, however, are not under the domination of the Smoke Act, and it seems to be a work of a supererogatory nature to prosecute manufacturers in Sheffield for a few whiffs of smoke from a boiler chimney when 40 furnace stacks below are belching out unmeasured volumes of the blackest clouds. In a recent case of prosecution it was shown that the steam boiler was only burning 13 lbs. coal per square foot of grate, and was fitted with suitable air admission, and that the smoke made really came from a heating furnace not under the smoke law. The onus of proof was with the prosecution, and the case was dismissed. Evidently Sheffield manufacturers are artful enough to use one chimney for both kinds of furnaces, and it will not be easy to prove a nuisance against the boiler, for the smoke will be laid to the charge of the other furnaces, to which the Public Health Act does not apply. It is said that smoke is even necessary for some qualities of steel. Of this we cannot speak. Probably it is not so, and probably gas firing could be employed for furnaces which are now such very serious smoke producers. If so, it would be desirable to further the use of such gas. But in Sheffield, where the magistrates are themselves almost all smoke producers, it will be difficult to enforce the Act very rigidly. We should like to see smoke abolished, but think there should not be unnecessary persecution.

Three-phase Transmission.—On the 18th inst., at Dudley, in connection with the South Staffordshire Institute of Iron and Steel Works Managers, Mr. J. H. Whittaker, A.M.I.E.E., read a paper on "Electricity in Mines and Iron Works; with Special Reference to Three-Phase Currents and Motors for Power Transmission."

He said electricity in mines and ironworks had been practically established for a number of years. Its use had been established on the continuous current system, and where properly installed and care exercised in the plan of installation, so that the plant was fully large enough to meet the maximum demands of the work it was intended to do, it had generally given satisfaction. There had been many failures, but they had been overcome. The great difficulties had been lack of proper strength of parts of plants, and inability to withstand dampness and water. The continuous current motor crane in large iron and steel works, of which the three-motor type was generally most satisfactory, and iron shielded or enclosed motors for all rough work, as pumping, hauling, driving, portable drilling, or other machinery in mines and ironworks were well known. The brushes and commutators were the great source of anxiety to owners of continuous current dynamos and motors. This trouble might be obviated by care on the part of the attendant, and the brushes made to last a year at least, and the commutator several years. Still there was the vital part of the machinery, and, unfortunately, motors did not get the care that was necessary to attain long life. The remainder of the paper was devoted to the subject of three-phase current machinery, which, the author remarked, was comparatively new in this country, only about a dozen plants being in operation. On the Continent, in America, and in South African mines, numerous and large plants were running, or being installed. The field for three-phase currents was undoubtedly in power distribution and transmission, although lighting also was being successfully carried out with the same plant as used for motor purposes. The chief characteristic of three-phase generators was that no current passed through the rotating parts. Consequently they required no brushes or commutator of any description, thus ensuring a much higher degree of durability and safety than was possible with any other electro-dynamic machines. The electromotive force capable of being generated by this class of machinery was very high. During the last few years a large number of generators had been made and fitted to work at various tensions up to 5,500 volts, and had, he believed, given entire satisfaction. Where power had to be transmitted distances over a mile, continuous currents were at a disadvantage, owing to difficulties of maintaining the insulation of the armature windings and commutator on high voltages. The highest voltage of continuous current in actual work in this country was, he believed, about 2,000, and with this voltage the machine had to be treated very carefully. In the case of continuous transformation 10 per cent. would be lost in the transformer, but with three-phase currents the full voltage could be used on motors of 25 horse-power and upwards, and if it must be reduced a loss in transformer would not exceed 4 per cent. For lighting purposes from the same mains three-phase currents were not quite so advantageous as continuous and direct currents. The efficiency and ease of transmission of three-phase currents offered strong inducements, however, to engineers to adopt them for transmission for any purpose, and to use rotary transformers giving out continuous currents at low voltage at the point of distribution for lighting purposes. The Manchester Corporation were having three-phase generators put down at their lighting station in the city to transmit currents at high voltage to the outlying districts—Salford, Moss Side, &c.—where it would be transformed into continuous currents at 250 volts. He had every confidence in stating that the superiority of the three-phase system for power work would soon make itself felt, and he hoped the Midland and South Staffordshire engineers and works managers would be among the first to reap something from the advantages of the system. A brief discussion followed.

Mechanical Draught.—The Sturtevant Company, who naturally wish to sell draught fans, state that a fan installation only costs from 20 to 40 per cent. of the price of a chimney, while it permits or enables a lower grade of fuel to be employed, as well as renders possible a fuller use of the heat. It is independent of weather, and helps to prevent smoke, saves space, is portable, is an assistance to an already overloaded chimney, and helps out a power station generally. The Holyoke Street Railway Company have put in two draught fans with automatic regulation for constant steam pressure. The fan bearings are water cooled, so that they cannot suffer from the heat; the stack extends just above the boiler house roof. Recent tests show an average economy for fan draught of 14·6 per cent. We think too little is being done in this country in fan draughts, especially in view of the many overloaded chimneys, and the general expense of chimneys and the loss due to the non use of economisers.

Deutsche Electro-chemische Gesellschaft.—The annual meeting of the Deutsche Electro-chemische Gesellschaft is to be held at Göttingen on May 25th, 26th and 27th next. Among the papers to be read is one by Prof. W. Nernst, of Göttingen, on "Electrical Electrolytic Conduction at very High Temperatures."

The Buffalo and Niagara Falls Electric Railroads.—The most stupendous deal that has ever occurred in electric traction affairs in the United States has been perfected in connection with the electric railroads in the vicinity of Buffalo and Niagara Falls. Under its terms all the railways of the city of Buffalo, the lines connecting that city with Niagara Falls and Lockport, the electric road of Niagara Falls and the Niagara Falls Park and River Railway on the Canadian side at Niagara, all fall into the possession of a syndicate capitalised at $25,000,000. While there is yet much believed to be back of the plans of the syndicate, it is known that it is proposed to retire all the stock bought with an issue of new bonds, while there will also be a new issue of preferred and common stock. This new issue of stock will be at a greatly increased capitalisation, in order to take care of the vast properties involved and allow a profit to be made on the investment. The electric roads whose future is concerned in the deal consist of the Buffalo Railway Company; the Buffalo Traction Company; the Buffalo, Bellevue and Lancaster Railway Company; the Buffalo and Niagara Falls Electric Railroad; the Buffalo and Lockport Road; the Niagara Falls and Suspension Bridge Railway; and the Niagara Falls Park and River Railway. But in addition to these electric roads the new syndicate becomes the possessors of two of the great Niagara bridges, one of them the fine new upper steel arch, owned by the Niagara Falls and Clifton Suspension Bridge Companies, and the other the proposed new suspension bridge now in course of erection across the Niagara gorge at Lewiston. These bridges will afford crossings for a belt line about the gorge, while the possession of the Buffalo and Niagara Falls road gives trackage facilities from Buffalo to the Falls on the New York side. As the Niagara Falls Park and River Railway now control a franchise for a line from Fort Erie to Chippawa on the Canadian side, it will be seen that they have all the rights for a belt line skirting the Niagara river on both shores from Lake Erie to Lake Ontario. Much of the stock of the several railway companies was bought below par, but it is understood that the stockholders of the Buffalo Railway Company will receive par; also that about 75 cents was paid for stock of the Buffalo and Niagara Falls road, and about 50 for the Buffalo and Lockport road. The amounts involved in the purchase of the various interests are about as follows:—

Buffalo Railway Company	$15,215,000
Buffalo Traction Company	3,858,000
Buffalo and Niagara Falls Railway	2,250,000
Buffalo and Lockport Railway	1,500,000
Niagara Falls Park and River Railway ...	1,000,000
Lewiston and Queenston Heights Bridge Co.	285,000
Total	$24,108,000

This statement above given is exclusive of the property of the Niagara and Clifton Bridge Company's property. Further announcements as to the ultimate scope and purpose of the big deal may be expected to follow soon. The bonds of the Niagara Fall and Clifton Bridge Company are out to the extent of about $400,000, and are understood to be equally divided between Canadian and United States capitalists.

Electrical Motors in a Printing Office.—Each press of the *Chicago Daily News* is equipped with two 5-H.P. six-pole motors of 200 revolutions maximum speed, suspended on the press at right angles to the main shaft. The motor shaft carries an automatic friction clutch and worm engaging with a brass gear wheel on the main shaft. This reduces the press shaft to a minimum speed of 10 revolutions per minute, with a steady movement free of jerks or jumps. Each motor is operated by a speed regulator with a compressed air cylinder and dashpot, arranged so that the motors can be adjusted to any speed through the rheostat. By simple movement of an air cock, the operator can move the press cylinders even a sixteenth of an inch. These small motors are, of course, employed in the adjustment and paper threading operations, &c. The main power is derived from a 40-H.P. slow speed multipolar motor, with simple reduction gear. It is controlled by a 55-point rheostat. By the convenience thus introduced, it is found that these electrically-operated presses give an increased output of 20 per cent., and save a lot of labour. There is now no breaking of the paper, and no clogging up, and injuries to men, especially in the threading-up operation, have been stopped.

The Article Club Industrial Exhibition.—The Article Club is arranging for an exhibition on a very lavish scale to be opened in May, and judging from the character of the preliminary announcements, we imagine that the Crystal Palace will be visited by engineering and electrical men in crowds. There will be over 100 exhibits, but each particular industry will have only one representative, as the rules of the Article Club do not admit competitive firms into membership. This so to speak exclusiveness will not, we are given to understand, prevent diversity in the exhibits, while it will have the advantage of avoiding that monotonous repetition which meets one in general exhibitions. The engineering section will be a particularly strong feature, while all the moving machinery at the exhibition will be driven by electric motors. The musical and sporting programmes are in the most eminent hands, the former being under Sir Arthur Sullivan's control, Dr. W. G. Grace being responsible for the latter. The doctor will captain an Article Club cricket team against one drawn from the Houses of Parliament.

Partnership and Change of Address.—Mr. A. H. Preece writes to say that as his father, Mr. W. H. Preece, C.B., F.R.S., Pres. Inst. Civil Engineers (late engineer-in-chief of the Post Office) is commencing practice as a consulting electrical engineer, he is giving up his present offices after March 25th, and will be associated with him at 13, Queen Anne's Gate, Westminster, S.W. Major Cardew, R.E. retired (who has been for the last 10 years electrical adviser to the Board of Trade) and Mr. Llewellyn Preece (Mr. A. H. Preece's brother) will also become partners with Messrs. Preece. The firm will be styled "Preece and Cardew."

Sterelectrolysis. — A new method of electrolysing minerals has been worked out by François Mayençon, and an account of it is given in the *Comptes Rendus Assoc. Franc. Adv. Sci.*, 1898, 26, (II.), 347-348. The name sterelectrolysis is given to the following method of analysing minerals. The fine powder is made into a paste with water, placed between two pieces of filter paper, and electrolysed between platinum electrodes with six dichromate cells. Metals or their oxides appear at the cathode, and acid radicles at the anode. For example, with galena, metallic lead and sulphuric acid are obtained, and with barytes, baryta and sulphuric acid. The separated constituents are then identified by ordinary analysis.

Municipal Corporations and Electrical Matters.—The Association of Municipal Corporations held its annual meeting in London last Saturday. Sir J. T. Woodhouse, who presided in the absence of Sir Albert Rollit, delivered a speech moving the adoption of the report, and made special reference to the telephone question, the municipal trading controversy, the electric power distributing schemes, and other matters affecting municipal bodies. As to the telephone question he said:—

> It must be gratifying to them all to find that the report of the Select Committee, of which he was a member, was substantially in harmony with the views expressed by that association, and it was also a cause of satisfaction that the Government had decided to legislate in accordance with the recommendations of the Select Committee. Some dissatisfaction had been expressed that the non-county boroughs were not treated by the Bill in the same way as the county boroughs, but he believed that the Government would reconsider that point in a manner favourable to the non-county boroughs.

On the other points he said:—

> As to the General Powers Distributing Bill, it must be a matter of great satisfaction to the municipalities that the House of Commons rejected the measure. They would have to be a good deal on their guard with regard to the Committee on municipal trading. There should, probably, be limits to municipal enterprise, and they did not want to transgress these limits so as to interfere with private traders, but when it was recognised that the origin of the Committee was largely the same as that of the Powers Bill, it behoved them to take care that they were not entrapped into preventing municipalities from progressing, as in the past, in reference to matters of a public character.

A resolution was passed to the effect that the provisions of any statute, enabling municipal corporations to provide a telephonic system should extend to all such corporations, whether county boroughs or not, provided that they were prepared to undertake the supply of telephonic facilities over such area as the Postmaster-General might deem reasonable and sufficient.

Obituary.—We deeply regret to notice the announcement of the death of Dr. Gustav Wiedemann, Professor of Physics at the University of Leipzig. Dr. Wiedemann's investigations in magnetism and electricity were very extensive, and he is well known as the author of works on the theory, his name being also lastingly associated with the *Annalen der Physik und Chemie*, of which he had been the editor since 1877. The magnetic relations of chemical combinations, electric discharges, the relations existing between the mechanical and magnetic properties of bodies, galvanism, electro-magnetism and Ohm's law, were among the special lines of research followed up by him. Deceased was in his 73rd year. He was a foreign member of the Royal Societies of Edinburgh and London.

Royal Institution.—The following are among the lecture arrangements after Easter:—Prof. Silvanus P. Thompson, two lectures on "Electric Eddy Currents" (the Tyndall Lectures); Prof. Dewar, three lectures on the "Atmosphere." The Friday evening meetings will be resumed on April 14th, when a discourse will be delivered by Prof. A. W. Rücker on "Earth Currents and Electric Traction." Succeeding discourses will probably be given by Prof. C. A. Carus-Wilson and others.

The Institution of Electrical Engineers.—We understand that the Institution of Electrical Engineers is to have a gathering in Switzerland some time in September. The idea is to visit the principal electrical works of which Zurich is a convenient centre.

Marriage.—The Electrical Review extends its hearty congratulations and best wishes to Mr. Sidney Rentell (proprietor of *Electricity*) on the occasion of his marriage to Sophie Pauline, eldest daughter of Mr. George Strohmenger, Bonnland, Quadrant Road, Canonbury, N. The event was solemnised on the 25th inst. at Unity Church, Upper Street, Islington, by the Rev. G. Dawes Hicks, M.A., Ph.D.

Wireless Telegraphy.—The *Times* of Wednesday contains a despatch sent by its Boulogne correspondent by wireless telegraph from Wimreux, a village on the French coast, to the South Foreland. The distance is 32 miles, and the vertical pole 150 feet high. Mr. Marconi conducted the experiments, and he left for England on Tuesday night along with officials of the French Government for continuing experiments at the Foreland.

Coast Communication.—The Earl of Derby, in the course of a speech upon the work and progress of that splendid organisation, the National Lifeboat Institution, paid a tribute to the importance of telephonic and telegraphic communication between lightships and the shore and to the great assistance so rendered to the life-saving work of the Institution. He was afraid, however, that electrical communications with lightships would always remain rather a difficult question, and a matter on which it would not do to place absolute reliance. There were technical difficulties which did not make communication so absolutely certain as it would require to be; but short of that, the communication with lighthouses in many cases was most useful, and the communication with the principal points of the coast had also been of great value. The recent developments in the application of wireless telegraphy in this direction do not appear to have come in for specific mention. We can hardly think that the Institution is not alive to the importance of their effect upon the future of coast communication.

General Post Office.—The Postmaster-General has been pleased to appoint Mr. W. H. Preece, C.B., to be consulting engineer to the Post Office.

Fire.—On Wednesday morning last a fire broke out on the premises of the Silvertown Telegraph Company, but it was speedily checked by the district fire brigade. The damage, which was slight, was confined to a building used as a store, and in no way interferes with the general work of manufacturing.

An Electrolytic Lamp.—Mr. Theo. Reyman, of New York, writes to the New York *Electrical World and Electrical Engineer* as follows:—

Having experimented with the oxides used by Prof. Nernst, I have designed a new form of lamp, which obviates the long wait before the oxide conducts the electricity. The apparatus I use is an arc lamp, the upper carbon of which is raised by a magnet connected in series to form an arc. Around the arc I have placed a hollow cylinder of oxide, connected in shunt around the arc. When the switch is turned on no current flows through the oxide, but as the carbons complete the circuit the magnet raises the upper carbon, and the arc thus formed heats its jacket of oxide, which soon conducts the electric current under the intense heat evolved and becomes incandescent. The arc between the carbon electrodes is broken, owing to the increased length of the arc and the reduced current which now passes through the incandescent cylinder of oxide. The upper carbon is fed by gravity when the current is turned off, prepared to again impart the initial heat. I have successfully operated three such lamps connected in series on 110 volts direct current.

NEW COMPANIES REGISTERED.

John Jenkins & Sons, Limited (61,136).—This company was registered on March 16th, with a capital of £70,000 in £1 shares, to acquire and carry on the business of builders' merchants, ironmongers, metal dealers, electrical and sanitary engineers, &c., now carried on at 34, 53, 55, and 57, Camberwell Road, Red Lion Row, Canal Street, Albany Road, and elsewhere in Surrey, as "John Jenkins and Sons," and to enter into an agreement with John Jenkins. The first subscribers (each with one share) are:—John Jenkins, Cheyne House, Denmark Hill, S.E., merchant; John Jenkins, jun., Holmdene Avenue, Herne Hill, S.E., merchant; Henry Rainford, Rosebank, Evelyn Road, South Wimbledon, clerk; Walter H. Jenkins, 2, Baysbrook Road, Streatham Hill, merchant; Charles J. Clark, Scoresby Street, Blackfriars Road, S.E., plate glass factor; W. H. D. Wayne, 22—4, Lower Kennington Lane, S.E., printer; and Frederick O. Wayne, 22—4, Lower Kennington Lane, S.E., printer. The number of directors is not to be less than three nor more than seven. The first are John Jenkins, Charles J. Clark, Samuel M. Waterfield, and John Jenkins, jun.; qualification, 200 shares; remuneration £200 per annum, divided between them. Registered office, 55, Camberwell Road, S.E.

Telephone and Switchboard Syndicate, Limited (61,146).—This company was registered on March 17th, with a capital of £10,000 in £10 shares, to carry on business as financiers, company promoters, underwriters, concessionaires, contractors for public and other works, capitalists, or merchants. The first subscribers (each with one share) are:—W. H. Sinclair, 8, Ducie Road, Oxford Road, Manchester, secretary; Arthur E. Cowley, Thornfield, Priory Road, Sale, secretary; John D. Haddock, 88, Broughton Lane, Manchester, secretary; Eugene Chevalier, 70, Derby Street, Hulme, Manchester, book-keeper; Wm. Cawthorne, 2, Florence Street, Hightown, Manchester, clerk; Charles E. Craig, 50, Bradshaw Street, Manchester, book-keeper; Ernest Griffiths, 251, Wellington Road South, Stockport, clerk. The business is vested in a manager or managers. The subscribers are to appoint the first.

Auckland Electric Tramways Company, Limited (61,199).—This company was registered on March 22nd, with a capital of £150,000 in £10 shares (7,500 preference), to construct, purchase, lease, or otherwise acquire any tramways or railways in Australasia, to equip, maintain, and work by electricity, steam, or other mechanical power, or by horse-power, any tramways or railways owned by the company, and to carry on the business of tramway, railway, omnibus and van proprietors, electrical engineers, electricians, contractors, manufacturers of electrical apparatus, suppliers of electricity, &c. The first subscribers (each with one share) are:—C. Rivers Wilson, G.C.M.G., C.B., Donington House, Norfolk Street, W.C.; C. W. Fremantle, K.C.B., Donington House, Norfolk Street, W.C.; Emile Garcke, Donington House, Norfolk Street, W.C., director; John S. Raworth, 46, Christchurch Road, Streatham, S.W., civil engineer; Stephen Sellon, Donington House, Norfolk Street, W.C., civil engineer; George Stevens, Donington House, Norfolk Street, W.C., secretary; and C. S. Drummond, Donington House, Norfolk Street, W.C., director. The first directors (to number not less than three nor more than five) are to be nominated by the subscribers; qualification, £100; remuneration, £50 each per annum and a sum equal to 5 per cent. of the ordinary dividend divided between them. Registered office, Donington House, Norfolk Street, W.C.

Interchangeable Flash Sign Syndicate, Limited (61,208).—This company was registered on March 22nd, with a capital of £5,000 in £1 shares, to acquire Provisional Patent No. 20,027 of 1898 granted to Arthur D. Douglass for "an interchangeable electric flash sign," to adopt an agreement with Douglass, Banks and Hinton, and to carry on business as electric flash sign manufacturers, advertising contractors, and electrical and mechanical engineers. The first subscribers (each with one share) are:—William T. Todd and W. T. Fowler, 25, Coleman Street, E.C., clerks; Herbert J. Murray, 14, Marquis Road, Stroud Green, N., clerk, H. A. Taylor, 49, Wool Exchange, E.C., solicitor; Alfred T. Palace, 49, Monsell Road, Finsbury Park, N., clerk; R. C. Oldham, 82, Park Lane, Croydon, artist; George F. Longden, Court Lodge, Brook Green, Hammersmith, artist. Table "A" mainly applies.

Argentina Electric Traction Company, Limited (61,211).—This company was registered on March 22nd, with a capital of £500,000 in £5 shares, to adopt an agreement with the Anglo-Argentine Tramways Company, Limited, to construct, equip, repair, maintain and work tramways under contract or as owners, and by electric traction or otherwise, and to carry on business as electricians, electrical and mechanical engineers, and suppliers of electricity. The first subscribers (each with one share) are:—E. A. Lazarus, 52, Threadneedle Street, E.C., bank manager; J. F. Nauheim, 56, Canfield Gardens, N.W., gentleman; Albert R. Monke, 88, Cannon Street, E.C., managing director; Alfred Clements, 118, Heath Street, Hampstead, secretary; Harold E. Charles, 49, Nunhead Lane, Peckham, clerk; James T. H. Hudson, Holly Bush House, Holly Mount, Hampstead, clerk; Henry A. Bumpus, 2, Lansdowne Road, Old Charlton, Kent, clerk. The first directors (to number not less than three nor more than five) are to be nominated by the subscribers; qualification, £500; remuneration, as fixed by the company.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Cambridge Electric Supply Company, Limited (36,457).—This company's annual return was filed on March 21st, when 9,423 shares were taken up out of a capital of £100,000 in £10 shares. £8 per share has been called on 4,970 shares, and £2 per share on 4,453, resulting in the payment of £48,666.

Scarborough Electric Supply Company, Limited (37,567).—This company's annual return was filed on March 13th, when 4,500 shares were taken up out of a capital of £50,000 in £10 shares, £9 per share has been called on 4,000, and £4 per share on 500, £38,083 (including £142 paid in advance) has been received, and £59 is in arrears.

The Telegraph Improvement Company, Limited (15,475).—This company's annual return was filed on January 17th, when 15,006 shares were taken up out of a capital of £100,000 in £1 shares; 15,000 are considered as paid, and £6 has been received.

Kensington and Knightsbridge Electric Lighting Company, Limited (26,193).—This company's annual return has just been filed. The capital is £350,000 in 50,000 ordinary, 10,000 first preference, and 10,000 second preference shares of £5 each. 15,000 ordinary, 10,000 first preference, and 6,687 second preference shares have been taken up, and 5,000 ordinary are considered as paid; £5 per share has been called on the others, and £133,435 has been received.

Northampton Electric Light and Power Company, Limited (28,640).—This company's annual return was filed on March 15th. The capital is £50,000, in 10 "A" and 49,990 "B" shares of £1 each; 10 "A," 17,288 "B" ordinary, and 7,000 preference shares have been taken up, and £1 per share has been called on 10 "A," 15,000 "B" ordinary, and 7,000 preference, while 10s. per share has been called on 2,288 "B" ordinary; £23,027 5s. has been received, and £249 5s. is in arrears.

CITY NOTES.

Willans & Robinson, Limited.

The tenth half-yearly report of the directors, submitted at the ordinary general meeting of the company, held at the City Terminus Hotel, Cannon Street, on Wednesday, March 29th, 1899, states that after writing off as depreciation from plant, patents, &c., the sum of £5,013 3s. 4d., and paying interest upon debenture stock, the balance to the credit of profit and loss account for the half-year (including £2,441 6s. 11d. brought forward) is £25,069 14s. 3d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares, and at 10 per cent. per annum upon the ordinary shares, together amounting to £12,000. The amount payable to the original directors, in accordance with the articles of association, is £3,863 10s. 2d., leaving a balance of £9,206 4s. 1d. From this the directors propose to carry £2,000 to the debenture redemption sinking fund, and £3,500 to the reserve fund, leaving a balance of £3,706 4s. 1d. to be carried forward. The balance of £11,124 14s. 6d., which stood in the last accounts to the credit of the share premium suspense account, has been disposed of, as follows:—£163 12s. 7d. has been written off removal expenses; £3,368 6s. 8d. has been written off the value of the freehold works at Thames Ditton, and £1,606 7s. 10d. off sundry items of plant at Thames Ditton. £986 7s. 5d. is kept in hand, in a removal suspense account, and £5,000 has been carried to the reserve fund. As the period of the accounts now presented corresponds with the conclusion of the fifth year of the company's working, it may be pointed out that the sums reserved out of profits in the five years, viz., £25,146 9s. 11d. in the reserve fund,* £10,000 in the debenture redemption fund,* and the balance of £3,706 4s.* 1d. now carried forward, amount together to £38,852 14s., and that this sum exceeds

* These sums include the appropriations named in the preceding paragraphs.

the amount paid for the goodwill of the business. The last year, and more particularly the last half-year, have been marked by a great increase in the demand for the special class of machinery which the company manufactures. As has been pointed out before, there has also been a rapid increase in the size of the engines the company is called upon to supply. Twelve months ago it was announced that an engine was on order to develop as much as 1,500 horse-power, a notable advance upon the sizes previously made by the company. Six months ago the directors were able to state that the number of such engines on order had increased to four. The number on order now is 16, and there is reason to expect that much larger sizes will be called for. The directors believe that the increased demand for engines, and especially for large engines, is due to permanent causes, and that it will continue to increase to an extent far exceeding the present producing powers of the company's plant. They also believe that if the company becomes unable to accept the orders offered to it, they will pass into the hands of foreign competitors, with permanent injury to the reputation of the company and to the interests of the shareholders. The directors are therefore of opinion that the plant should be increased, and that larger and more powerful tools should be provided. The directors also consider that the manufacture of the Niclausse boiler should be taken up upon a larger scale than has hitherto been contemplated, or than is possible at Rugby. Under these circumstances the directors propose to take the existing boiler shop at Rugby as an additional machine shop, and to make some other additions, adding in all about 60 per cent. to the space now available for machine tools; they also propose to double the size of the foundry. They propose to erect separate boiler works upon a site which has been secured near Chester, upon the river Dee, with the advantages of cheap sea carriage for materials, and easy railway communication with Rugby and other important centres. The foregoing scheme has had the very careful consideration of the directors, who are satisfied as to its advantages and its necessity. It will render necessary an increase of capital, and resolutions will be submitted to the meeting authorising the creation of 40,000 new shares of £5 each, for one-half of which the directors propose to invite subscriptions in the course of the ensuing month, to provide for the necessary new buildings and plant, and to supply additional working capital. Subject to the concurrence of the existing preference shareholders, it is proposed to follow the system which is believed to have worked hitherto to the satisfaction of both classes of shareholders, and to take power to issue half the new shares as preference and half as ordinary shares.

The County of London and Brush Provincial Electric Lighting Company, Limited.

The report to be presented to the shareholders at the fifth ordinary general meeting of the company states that the capital expenditure during the year, in respect of the company's London districts, amounted to £148,797 16s. 2d., making the total expenditure on account of those districts, up to December 31st last, £562,587 6s. 2d. This expenditure was met mainly by the balance of instalments falling due on the 10,000 ordinary shares issued at par, and allotted *pro rata* to the ordinary shareholders on December 6th, 1897. The net revenue for the year, including the balance from last account, and after payment of proportion of rents, rates, taxes, interest, and general establishment charges, is £17,375 18s. 6d. Out of this sum an interim dividend on the preference shares for the half-year ended June 30th last, at the rate of 6 per cent. per annum, has been paid, and the directors now recommend that a further dividend on the preference capital for the half-year just ended, be declared at the same rate. This will leave a balance of £5,775 18s. 6d., which it is proposed to carry forward. In the above amount nothing is included for the considerable increase in value that has taken place in the company's investments, which stand in the balance-sheet at cost. The company is promoting a Bill in the present session of Parliament, the main objects of which are to enable the company to obtain compulsory powers for acquiring lands and securing rights of way for the purpose of connecting its various London districts. A special resolution approving this Bill was passed at an extraordinary general meeting of the shareholders held on January 16th, 1899, and confirmed at a subsequent extraordinary general meeting held on February 13th last.

The fifth ordinary general meeting of the shareholders of this company was held on Monday last at Winchester House, Old Broad Street, Lord Rathmore presiding.

The Chairman, in proposing the adoption of the report, said he thought the shareholders would agree with the board in thinking that on the whole the report was very satisfactory and encouraging. They thought it was satisfactory in the proof that it gave of the steady progress of the business, and encouraging in the hope that it held out of substantial rewards in the near future, and greater successes which he believed would follow. That company was still passing through the transition stage, through which all undertakings similar to theirs had had to pass; but the disappointments and trials they met with were only of temporary and accidental character, and the record of the past 12 months confirmed their confidence in the inherent value of their undertaking, and in the favourable prospects which they believed lay before them in the near future. The capital expenditure during the year on their London stations had amounted to £148,798, of which £104,906 was on account of mains, transformers, motors and meters, and of that £104,000 £45,322 was in respect of Camberwell and £12,828 for Eastern Holborn, much of which expenditure was, of course, for the moment necessarily unproductive. Of course in the future they looked forward confidently to a good return from the money so laid out. With regard to the revenue at the London stations, they must remember that this was the first completed year of working at these two stations, and that therefore a good deal of the expenditure had not yet been remunerative. The gross revenue from the London stations had amounted to £22,261, which was as much as they could fairly have expected under the circumstances. The proportion of net revenue to gross revenue at the North London station was not very satisfactory, but there were exceptional causes for that, which would probably not occur again. Coal had cost them much more than usual, and already this year, in that respect alone, Mr. Lawson, their engineer, had been able to make a reduction of ¼d. per unit, and he hoped that before the year was out that reduction would amount to ½d. They were able to consider the results of the Wandsworth station altogether satisfactory, because there they found that out of a total of £11,042 received £4,958 was clear profit. Mr. Lawson estimated that the sales of both the St. Luke's and the Holborn district for the present quarter, March, would be equal to those of the December quarter, which was the best quarter of the year, and he also hoped that that rate of progress would be sustained to the end of the year, and if that expectation was fulfilled he further estimated that the result of the sales of current in Wandsworth during the present year would be double that which it was in 1898, and that in the case of St. Luke's it would be three-fourths more. If those estimates were realised, the result would be a very much larger proportion of net profits to gross receipts, because while there would be a considerable increase in the receipts, the standing charges at the stations would remain practically stationary. Although it might be said that the results of their two London stations last year did not lack very largely in the accounts of last year, yet he believed the results already achieved were in excess of the results achieved by similar undertakings in London in the same period. They hoped to have a large demand for the supply of power, and already they had had applications for motors equivalent to about 300 horse-power, and there were negotiations still under consideration for a much larger amount of power supply. That would be of very great value to them, because the load in summer for lighting purposes must necessarily be a light one. The shareholders were probably aware that the company had a Bill which had passed the House of Commons, and which was now under consideration by a Select Committee. That Bill would enable them to cope much better with the demand for the supply of current which had already developed, and also for the increased demand which they confidently expected in the future in their existing districts, and also in any new district which they might afterwards acquire. The Bill would also enable them to get across intervening areas, now separated in some cases by the central stations from outlying districts. They felt confident that that Bill would soon pass into law, and would enable them to conduct their business more economically and efficiently, not only in their own interests but also in the interests of the consumers. He hoped that by the time of the next annual meeting he would be able to inform the shareholders that all their principal mains in the Camberwell, St. George-the-Martyr, and St. Olave's districts had been completed and were bringing in a substantial revenue, and he also hoped that the mains would be laid through Western Holborn. As regarded their provincial undertakings, they had very good reason to be satisfied with their investment in the Richmond Company, an investment which, he believed, would considerably enhance in value in the near future. At Dover the progress had been very satisfactory, the gross revenue there having been increased by a little more than £1,000. At Bournemouth there had been very rapid and continuous progress. The company there had been able to declare a dividend of 4 per cent. for the past year, and there could be no doubt that, as time went on, the value of that investment would be considerably enhanced. Reviewing the whole matter, he was sorry that they were not in a position to declare a dividend yet, but the board did feel that the period of patience and probation had now almost ended, and that they might look forward with confidence to the future for a substantial, steady, and rapid success.

Mr. J. B. Braithwaite (deputy chairman) having seconded the motion, it was carried, after some discussion.

Dover Electricity Supply Company.

Sir William H. Crundall presided on 15th inst. at the fifth ordinary general meeting of this company.

From a report supplied to us we understand that the Chairman stated that the year's accounts showed a material improvement in the company's position. He desired to remind the shareholders that some five or six years ago it was mooted that the municipal authorities should take up the supply of electric light in the town, he then holding the office of Mayor. He could not persuade some of his colleagues to do this, but was determined that the town should have the benefit of an electric supply. It therefore became his duty to cast about for the means of finding capital for the new enterprise. He was fortunate enough to meet his colleague, Mr. Sellon, who introduced him to Mr. Lawson. Through the kindness of the Brush Electrical Engineering Company and the County of London and Brush Provincial Electric Lighting Company, capital had been found, and the works erected and equipped. He was reminded that at Eastbourne the Corporation had just agreed to take over the electric undertaking at something like 100 per cent. above the capital outlay, and knowing Eastbourne he thought he might say that the Dover station was a better one and that they had got a very valuable property which was capable of enormous development. The shareholders would no doubt have heard that there had lately been a movement in Dover to take over their concern, but it seemed to him that the

company could have no desire for negotiations, at any rate on the present basis of the earning power of the company. For 1898 a 2½ per cent. dividend would have been able to have been paid on the whole capital employed but for the fact that a considerable amount had had to be paid for interest on advances. These advances would now be paid off, the whole of the share capital having been issued, and a premium as high as £1 per share had been obtained on some shares dealt in. He hoped that they would earn and distribute a considerably larger percentage in respect of the present year. There was practically no limit to the amount which they could pay in dividends, and he hoped that it would not be long before they were paying, say, 12½ per cent., which they could do without reducing their present rate for current. He might remind the shareholders that any sale on the part of the company for the next 12 years would be entirely a matter of negotiation, and even then, though compulsory, the undertaking would have to be bought as a going concern. The progress of the company had been exceptionally good; a loss of £950 on the first nine months' working in 1895 was reduced in 1896 to a loss of £450; in 1897 the profit was £1,100; and in 1898, as they would see, the profit had risen to £2,200. Though the Corporation, if they desired to take over the concern, would have to pay a very heavy premium, he thought that nobody would wish the company had not started, as perhaps then they would still be without the electric light, and he thought nobody would care to return to the days of gas and candles, and when the electric cars did not exist. With regard to the accounts for 1898, the further capital expenditure had been for the purpose of meeting the increased demand, and he hoped that still further calls for the expenditure of capital would be necessitated for the same reason. In view of the fact that every one of the ordinary shares had now been placed, and that the loan would be extinguished with the proceeds, and that they hoped, also, to extinguish the debit standing to the debit of profit and loss account, he thought that the position was very satisfactory. The lamp connections at the end of the year had been approximately 12,500. The plant capacity had been raised in 1898, so that it would deal with about 26,000 lamps connected; this meant that with the present plant nearly double the revenue could be earned, and that a much larger revenue-earning capacity could be reached by the expenditure of comparatively small additional amounts. He was glad to say that a contract had been entered into for the supply of light, and probably a certain amount of power, to the contractors for the National Harbour. In addition to this the applications for ordinary lights had been 50 per cent. more than those received in the corresponding period of last year. The directors and their friends held a very considerable portion of the capital of the company, and they would therefore do their best in the interest of the company, but he desired to also thank the staff for their services. He moved the adoption of the report and accounts.

Mr. B. H. Van Tromp seconded the resolution, which was carried.

The retiring directors and auditors were re-elected, and a vote of thanks to the chairman terminated the proceedings.

The Richmond (Surrey) Electric Light and Power Company, Limited.

The report presented to the general meeting of the company, held at Moorgate Court, Moorgate Place, London, E.C., last week, states that the capital account shows an expenditure during the year of £6,452 12s. 3d., chiefly upon machinery and mains, making a total sum of £51,246 4s. expended to December 31st last. The balance to credit of net revenue account, including the amount brought forward, and after payment of interest charges and reduction of suspense account, is £1,340 12s. 4d. Out of this sum the directors recommend the payment of a dividend on the ordinary shares of the company at the rate of 4 per cent. for the year, less income-tax, which will absorb £1,211 8s. 6d., thus leaving £129 3s. 10d. to be carried forward to next account. The equivalent of 12,352 8-C.P. lamps were connected to the company's mains at December 31st last, showing an increase equivalent to 2,840 8-C.P. lamps connected for the year. In order to meet the rapidly increasing demand for current, additional plant has been installed, and further additions will be made during the present year. Considerable extensions have been made to the company's mains, and further extensions are in contemplation.

The Exploration Company, Limited.

At the annual meeting on 22nd inst., Mr. H. Mosenthal, who presided, in the course of his speech regarding the operations of the above company, said that there had been no alteration in the company's holding in the shares of the Central London Railway. Its opening had been delayed beyond their expectations owing to unforeseen difficulties, but they were satisfied that, when the line was opened, it would be found to meet a real want and benefit shareholders in proportion to its utility. Their shareholding in the Electric Traction Company had been slightly increased. Their report referred to the satisfactory position of the Compagnie Générale de Traction, the ordinary and founders' shares of which were largely held by them. The position had still further improved since the issue of their report, inasmuch as the concessions for electric tramway lines *de pénétration* for Paris asked for by the Compagnie Générale de Traction and approved by the Conseil Générale de la Seine, received the sanction of the Conseil d'Etat last Thursday, and it was expected that the official decree, enabling work to commence, would issue immediately. Through the enterprise of the Compagnie Générale de Traction they were confident that Paris and its suburbs would at no distant date be covered with a network of electric tramways of over 200 kilometres of new lines; and such lines as were of importance to the great Paris Exhibition of 1900 would be in working order at the time of opening.

Commercial Cable Company.

The report of the directors for the year 1898, presented at the annual meeting held on 6th inst., stated that the net traffic earnings from cables and landlines increased $107,410 over the previous year. Out of the balance to the credit of revenue account there had been set aside a sum of $350,000 as an addition to the reserve fund and also an amount of $100,000 to the fund for insurance of stations, apparatus, and repair steamer, and these sums would be invested in first-class securities. The reserve fund amounted to $3,037,103, and the insurance fund to $200,000. During the year there had been issued $2,000,000 4 per cent. first mortgage bonds. The proceeds from this issue had been partly expended in acquiring the property of the Pacific Postal Telegraph Cable Company and further extensions of landlines, thereby adding to the company's landline system 3,449 miles of poles, 12,841 miles of wire, and 468 offices. After providing for all operating expenses and reserves, the balance of net revenue, including the amount brought forward from the previous year, amounted to $1,908,759, out of which had been paid interest on the bonds and debenture stock ($704,296), and dividends and bonus on the capital stock ($800,000), leaving a balance of $404,462 to be carried forward to the present year.

National Electric Free Wiring Company.—Mr. R. S. Bain, who presided at the meeting of this company in London last week, said that considering the business was a new one, the directors had every reason to be satisfied with the progress made and the prospects of the future. They had entered into contracts with various places, and opened offices at Blackpool, Bradford, and other places in the North of England. They started the year with only 85 installations, they finished it with 680, all of which were revenue bearing. The directors had inaugurated a system of wiring on the hire-purchase system. The report was adopted, and the name of the company altered to the National Electric Company, Limited.

The Direct United States Cable Company, Limited.—The board have resolved upon the payment of an interim dividend of 3s. per share, free of income-tax, being at the rate of 3 per cent. per annum, for the quarter ending March 31st, 1899, such dividend to be payable on and after April 26th next.

Smithfield Markets Electric Lighting Company.—On Monday last, at the offices in Throgmorton Street, an extraordinary general meeting of the shareholders of the above-named company was held, at which the resolutions submitted to and passed by a previous meeting for the purpose of authorising the alteration of the articles of association of the company, with the object of enabling the company to obtain a quotation of the shares on the Stock Exchange, were duly submitted and confirmed.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee (1) to appoint a special settling day in and to grant a quotation to:—City and South London Railway Company—37,500 ordinary shares of £10 each; to appoint a special settling day in:—Doulton & Co., Limited—233,334 5 per cent. cumulative preference shares of £1 each.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending March 25th, 1899, were £174 15s. 6d.; aggregate to date, £2,087 13s. 5d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending March 24th, 1899, were £2,321 11s. 7d.; corresponding period, 1898, £2,397 14s. 7d.; decrease, £58 3s.

The City and South London Railway Company.—The receipts for the week ending March 26th, 1899, were £1,108; week ending March 27th, 1898, £1,066; increase, £42; total receipts for half-year, 1899, £14,386; corresponding period, 1898, £13,892; increase, £494. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending March 25th, 1899, were £124 13s. 3d.; week ending March 26th, 1898, £111 9s. 8d.; increase, £13 3s. 6d. Total receipts to date, 1899, £1,696 12s. 10d.; corresponding period, 1898, £1,277 18s. 7d.; increase, £418 14s. 3d. Miles of track open week ending March 25th, 1899, 3; week ending March 26th, 1898, 3. Car miles run week ending March 25th, 1899, 4,358; week ending March 26th, 1898, 3,699. Number of cars, week ending March 25th, 1899, 11; week ending March 26th, 1898, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, March 24th, 1899, were as follows:—D. U. T. Co., horse cars, £1,462 3s. 10d.; ditto, electric cars, £821 16s. 11d.; D. S. D. Co., electric cars, £556 19s. 7d.; total, £2,841 0s. 4d.; corresponding week last year—D. U. T. Co., horse cars, £2 288 14s. 4d.; ditto, electric cars, £326 10s. 4d.; D. S. D. Co., electric cars, £417 17s. 2d.; total, £3,028 1s. 10d.; decrease, £187 1s. 6d.; aggregate to date, £38,106 12s. 1d.; ditto last year, £36,274 11s. 3d.; increase to date, £1,832 0s. 10d. Worked:—The mileage open is 18 miles electrically, 26 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending March 26th, 1899, amounted to £1,269; corresponding week last year, £1,303; decrease, £34.

The South Staffordshire Tramways Company.—The receipts for week ending March 24th, 1899, were £542 12s. 7d.; aggregate receipts for 12 weeks, £7,092 12s. 10d.; week ending March 25th, 1898, £562 11s. 8d.; aggregate receipts for 12 weeks, £6,904 11s. 5d.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, March 22nd.	Closing Quotation, March 28th.	Business done during week ended March 28th, 1899. Highest.	Lowest.
124,400*l*	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	103	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	87 — 92	87 — 92	...	...
905,560*l*	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	65 — 68	65 — 68	...	...
3,047,220*l*	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	116½—117½	117½—118½	118⅛	117¼
3,047,220*l*	Do. do. Deferred...	Stock	...	...	18s. %	13¾— 14½	14½— 15	14⅝	14½
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	...	16 — 16½	16 — 16½	16¼	16
75,000*l*	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2½— 3	2½— 3	2⅝	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	190 —200	190 —200	...	...
1,332,523*l*	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	105 —107	105 —107	106½	106⅜
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	...	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	7 %	...	9 — 10	9 — 10	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	17½— 18½	17½— 18½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	...	106 —109	106 —109%	...	...
60,710*l*	Direct United States Cable	20	2½ %	...	...	12¼— 12¾	12¼— 12¾	12 7/16	...
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	103 —106	103 —106	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	...	...	...	180 —185	180 —185	181½	180
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	103 —106	102 —105	...	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	99 —102	99 —102	...	...
1,432,268*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	125 —129	125 —129	...	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	18 — 18½	18 — 18½	18 5/16	18
16,200*l*	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	99 —103	99 —103	...	...
64,460*l*	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	100 —103	100 —103	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	125 —129	125 —129	125	...
35,100*l*	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	99 —103	99 —103	...	...
46,500*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	100 —103	100 —103	...	...
300,000*l*	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	102 —105	102 —105	...	...
200,000*l*	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	104 —107%	104 —107%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	...	12⅜— 13¼	12⅜— 13¼	13⅛	12⅜
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	16¾— 17½	16¾— 17½	17 1/16	16⅝
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	30 — 31	30 — 31	30⅛	...
97,800	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	57 — 60	57 — 60	...	...
100,000*l*	London Platino-Brazilian Telegraph, 6 % Debs. ...	100	6 %	6 %	...	108 —111	108 —111	...	...
484,597	National Telephone, 1 to 484,597	5	5½ %	6 %	6 %	4½— 5	4½— 5	4 1/16	4⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	11 — 13	12¼	12⅛
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	11 — 13	12⅛	12
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4¾— 5¼	4¾— 5¼	4⅝	4⅝
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	99 —101	99 —101	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅞— 1	⅞—1	15/16	...
100,000*l*	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	...	6½— 7½	6½— 7½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 —145	140 —145	...	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4¾— 5¼	4¾— 5¼	5⅛	...
151,733*l*	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000*l*	West African Telegraph, 5 % Debs.	100	5 %	5 %	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	103 —106	103 —106	...	...
389,521	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Telegraph	10	1 %	3/4 %	...	1⅞— 2⅛	2 — 2¼	2⅛	2
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	10½— 11	10½— 11	10 1/16	10⅝
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000*l*	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	105 —108	105 —108	...	...
158,100*l*	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	100 —103	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	11½— 12½xd	10 — 12	11¼	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½xd	6 — 6½	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	6 %	8 — 9	8 — 9	8 3/16	...
60,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	4½ %	...	114 —116	114 —116	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	7 %	10 %	6 %	18 — 19	17 — 18	18½	17
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15 — 16	15 — 16	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	124 —129	124 —129	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	nil	*nil*	11 — 12	11 — 12	11⅜	11¼
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14 — 15	14 — 15	...	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	5 %	...	5¼— 5⅜	5¼— 5⅜	...	...
15,661	House-to-House Electric Light Supply, Ord., 101 to 15,761	5	...	4 %	6 %	8½— 9½	8½— 9½	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9 — 10	9 — 10	9⅝	9½
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3½— 4	3½— 4	...	...
48,050	Do. do. do. 6 % Pref.	5	...	...	6 %	6½— 7 xd	6½— 7	...	...
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	105 —107	105 —107	106	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	5 %	16 — 17	16½— 17½	17¼	16½
22,500	Do. Nos. 62,501 to 85,000, £7 paid ...	10	...	...	...	12 — 13	12½— 13½	13	...
220,000*l*	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	...	117 —120	117 —120	118	117¼
6,452	Notting Hill Electric Lighting	10	4 %	6 %	6 %	16½— 17½	16½— 17½xd	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½ %	14½ %	14½ %	17 — 17½	17 — 18	18	17½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	3⅛— 3⅜	3⅛— 3⅜	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	12 %	15½— 16	15½— 16½	16	15½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‖ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation Mar. 22nd.	Closing Quotation Mar. 28th.	Business done during week ended Mar. 28th, 1899. Highest	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	...	...	...	3 — 3½	3 — 3½	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	94 —100	94 —100	98½	...
30,000	British Electric Traction	10	...	...	6 %	19½— 20	19½— 20	20¼	19¾
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13¾— 14¼	13¾— 14¼	14 1/16	13⅞
100,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	126 —129	126 —129	128	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	*nil*	*nil*	...	1⅞— 2⅛	1⅞— 2⅛	2 1/16	2
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	*nil*	4 %	...	2⅛— 2⅜	2⅛— 2⅜	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	...	...	...	12½— 13½	12½— 13½	12¾	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	114 —117	114 —117	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	9¾— 10¼	9¾— 10¼	...	...
178,303	Do. do. do. £8 paid	10	...	...	...	7¾— 8¼	7¾— 8¼	...	...
61,033	Do. do. Pref. half-shares £3 paid ...	...	...	...	...	3½— 4	3½— 4	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	4¼— 4¾	4¼— 4¾	...	...
630,000*l*	City and South London Railway	Stock	1 1/16 %	1⅞ %	2⅛ %	68 — 70	68 — 70	68	...
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £5 pd.	10	...	...	...	4¾— 5¼	4¾— 5¼	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	3¼— 3¾	3¼— 3¾	...	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	98 — 101	98 —101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5½ %	6 %	...	2¼— 2¾	2 — 2½	2¼	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5½ %	6 %	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	97 — 99	97 — 99	98¼	...
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2¼— 2½	2⅛— 2⅜	2⅜	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3½	3 — 3½	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —106	103 —106	105½	103½
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅝— ⅞	½— ¾	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	⅝— ⅞	½— ¾	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	14 %	26 — 27	26 — 27	26 9/16	26
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18½— 19½xd	18½— 19½	19¼	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	4½ %	...	112 —115 xd	112 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21½— 22½	21½— 22½	22 3/16	21⅞
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	101 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞ %	3¼ %	3½ %	10 — 10½	9 15/16 —10 1/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14⅝— 14⅞	14⅝— 14⅞	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	38 — 42	38 — 42	40	38½
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	104 —107	105 —108	106¾	106¼
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	9¾— 10¼	9¾— 10¼	...	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5¾— 6¼	5¾— 6¼	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	109 —112	109 —112	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10¼.
British Aluminium, Ordinary, 10½—11½; 7 % Pref., 12—13.
House-to-House, 4½% Debentures of £100, 104—107.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12½—13½; 1st Preference Cumulative 6%, £5 (fully paid), 7¾—8¼. Debentures, 107—110. Dividend, 1898, on Ordinary Shares 10%.
National Electric Free Wiring, 10s. paid, ⅜—½.
Smithfield Market Electric, 3½—4½.
*T. Parker, £10 (fully paid), 15¾.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (February 2nd, 1899).

MARKET QUOTATIONS, Tuesday, March 28th.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a „ Nitric .. .. .. per cwt.	22/-	22/-	..
a „ Oxalic .. .. .. per cwt.	32/-	32/-	..
a „ Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	37/-	37/-	..
a Ammonia, Muriate (grey) .. per ton	£19	£19	..
a „ „ (white) .. per ton	£26	£26	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a „ (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£25 10	£25 10	..
a Lead, Nitrate .. .. .. per ton	£23 10	£23 10	..
a „ White Sugar .. .. per ton	£30 10	£30 10	..
a „ Peroxide .. .. .. per ton	£37 10	£37 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	3¾d.	3¾d.	..
a „ Caustic (75/80 %) .. per ton	£24	£24	..
a „ Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	68/-	67/-	1/- inc.
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 15	£6 15	..
a „ Recovered .. .. per ton	£5 15	£5 15	..
a „ Lump .. .. .. per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a „ Crystals .. .. .. per ton	£3	£3	..
a „ Bichromate, casks .. per lb.	3d.	3d.	..
METALS, &c.			
b Aluminium Wire, in ton lots .. per ton	£224	£224	..
b „ Sheet, in ton lots.. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£65 to £130	£65 to £130	..
c Brass (rolled metal 2" to 12") basis per lb.	7⅞d.	8¼d.	¼d. dec.
c „ Tube (brazed) .. .. per lb.	10d.	10d.	..
„ Wire, basis .. .. per lb.	8d.	8¼d.	¼d. dec.

METALS, &c. (*continued*).	This week.	Last week.	Increase or Decrease.
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f „ Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£78	£77	£1 inc.
g „ Wire (basis price) .. per lb.	9¾d.	9¾d.	..
g „ Sheet .. .. .. per ton	£78	£77	£1 inc.
g „ Rod .. .. .. per ton	£78	£77	£1 inc.
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	6/-	6/-	..
h India-rubber, Para fine .. per lb.	4/4½	4/4½	..
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i „ Pig (Cleveland warrants) per ton	48/3	48/2	1d. inc.
i „ Forgings, according to size per ton	From £11	From £11	..
i „ Scrap, heavy .. .. per ton	50/- to 55/-	50/- to 55/-	..
i „ Wire galvanised No. 8 .. per ton	£9 5	£9 5	..
g Lead, English Ingot .. .. per ton	£14 10	£14 15	5/- dec.
g „ „ Sheet .. .. per ton	£15 2 6	£15 2 6	..
l Mica (uncut slabs 8" long) .. per lb.	6/6	6/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£8 5	£8 5	..
p Phosphor Bronze, plain castings per lb.	1/- to 1/4	1/- to 1/4	..
p „ rolled bars & rods per lb.	1/- to 1/4	1/- to 1/4	..
p „ r'l'd strip & sheet per lb.	From 1/2	From 1/2	..
o Platinum .. .. per oz.	£3 10	£3 11 6	1/6 dec.
p Silicium Bronze Wire .. .. per lb.	10d. to 1/1	10d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£112	£111	£1 inc.
g „ foil .. .. per lb.	1/6	1/6	..
n „ wire Nos. 1 to 16 .. .. per lb.	1/6	1/6	..
p White Anti-friction Metals— "White Ant" brand .. per ton	£40 to £	£40 to £65	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	7½d.	7½d.	..
j „ Flax, 6 or 8 lea... .. per lb.	4d.	4d.	..
j „ Hemp, 3 ply 10 lbs. .. per lb.	3½d.	3½d.	..
j „ „ Russian, 10 lbs. per lb.	4½d.	4½d.	..
j „ Jute, 180 lbs. rove .. per ton	£12	£12	..
j „ Manila, 24 thread .. per ton	£34 10	£33 10	£1 inc.
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£31	£31	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d
e

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yeo & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
l Messrs. Sanders, Wake & Co.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

INSULATION TABLES.—(*Continued from page* 480).

Authority.	Insulation resistance complete installation.		Pressure.		Motors.		Arc lamps.	Minimum insulation after supply has been commenced.	Range of specification	Insulation resistance per 64-watt lamp.	Insulation resistances of conductors meghom-miles.
	To earth.	Between mains.	Testing.	Working.	Insulation required.	Mounting.	Insulation per lamp required.				
Liverpool.	$\frac{20,000,000}{A}$	$\frac{20,000,000}{A}$	200 volts	230 volts	Follows from ins. res. test, but not less than 50,000 ohms is specified	To be insulated	Not specified. Follows from ins. res. test	"Limit of safety." Not specified	No limit	230 v. 72 meg.	Not less than 600 megohms
Manchester.	Mc lamps. / Ohms. 25 / 2,000,000 50 / 1,000,000 75 / 666,000 100 / 500,000 200 / 250,000 300 / 167,000 400 / 125,000	Method of making test not definite	Not specified	100, 200, 300, and 400 volts	1 megohm	Frame, &c., earthed. Earthing connection of equal size to motor leads	Per circuit, 5 megohms (for 15 amp. lamps)	$\frac{A}{10,000}$	No limit	50 megohms per lamp up to 50 C.P.	Exterior wiring, 2,500 megohms; other conductors in no case less than 600 megohms. Rubber-covered cables. Paper or bitumen insulated cables and lead covered, 250 megohms.
Newcastle and District.	No rules issued.	Phœnix Fire Office Rules in force.									
Nottingham.	Lamps. / Meg. 10 / 7·5 20 / 3·75 30 / 2·5 40 / 1·9 50 / 1·5 75 / 1 100 / ·75 150 / ·5 200 / 3·75 250 / ·3 300 / ·25	Method of making test not definite	100 volts	100 volts and 200 volts	To be equal to the insulation resistance required for the number of lamps requiring the same energy.	To be insulated	Not specified	"Becomes defective." Not otherwise specified.	300 lamps	75 megohms.	Not less than 300 megohms.
Oxford Electric Co.	Lights. / Ohms. 25 / 500,000 50 / 250,000 100 / 125,000 500 / 25,000 1,000 / 12,500	Method of making test not definite	Not specified.	100 volts	To be approved by the Company.			Lights. / Ohms. 25 / 500,000 50 / 250,000 100 / 125,000 500 / 25,000 1.000 / 12.500	1,000 lights	12·5 megohms.	Not specified. Conductors to have "one coating pure rubber and one of vulc. rubber of approved thickness."
Vestry of St. Pancras.	$\frac{10,000,000}{A}$	Not specified	Not specified	220 volts	Follows from ins. res. test. Not otherwise specified	Not specified	Follows from ins. res. test. Not otherwise specified	$\frac{10,000,000}{A}$	No limit	220 v. 34·5 meg.	Not less than 2,500 megohms
South Shields.	$\frac{50 \text{ megohms}}{N}$	$\frac{100 \text{ megohms}}{N}$	Not specified	110 volts and 220 volts	To engineer's approval			"Defective or otherwise unsafe." Not otherwise specified	No limit	50 megohms to earth.	In dry places, 300 megohms; in damp places, 600 megohms. Buried or inaccessible conductors, 2,000 megohms
Wolverhampton	$\frac{40,000,000}{A}$	Not specified	Not specified	110 volts and 220 volts	Follows from ins. res. test, and is so specified	To be insulated	Follows from ins. res. test. Not otherwise specified	Not specified	No limit	110 v. 69 meg. 220 v. 138 meg.	Not specified. Conductors to have one coating pure rubber and one of vulc. rubber of sufficient thickness.

INSULATION TABLES (*continued*).

Authority.	Insulation resistance complete installation.		Pressure.		Motors.		Arc lamps.	Minimum insulation after supply has been commenced.	Range of specification	Insulation resistance per 64-watt lamp.	Insulation resistances of conductors megohm-miles.
	To earth.	Between mains.	Testing.	Working.	Insulation required.	Mounting.	Insulation per lamp required.				
Sunderland.	Lamps. Meg. Up to 12 2·5 12 to 25 1·25 25 to 50 1·00 50 to 75 0·75 75 to 100 0·5 100 to 150 0·3 150 to 200 0·25 200 to 250 0·2 250 to 300 0·15	In no case less than 75,000 ohms.	200 volts	110 volts and 220 volts	Not specified	Not specified	Not specified	5,000 ohms	300 lamps	Varies between 30 and 56 meg., according to the number of lamps installed	Not less than 1,000 megohms
The London Electric Supply Corporation.	Lamps. Meg. 25 2 50 1·25 100 ·75 150 ·5	Method of making test not definite	Not specified	...	Not specified	Not specified	Not specified	Lamps. Meg. 25 2 50 1·25 100 ·75 160 ·5	150 lamps	Varies between 50 and 75 meg., according to the number of lamps installed	Not specified. Conductors to have "one coating pure rubber and one vulc. rubber of approved thickness"
The City of London Electric Lighting Co.	75 megohms Points	Method of making test not accurate	Not specified	100 volts and 200 volts	To engineer's approval			Not specified	...	...	Not specified
Westminster Electric Supply Corporation.	Lamps. Meg. 12 3 25 2·5 50 1·5 75 1·25 100 1·0 150 0·75 200 0·5 250 0·3 300 0·2	In no case less than 75,000 ohms.	100 volts	100 volts and 200 volts	To be equal to the ins. res. required for the number of lamps taking the same energy	To be insulated	Not specified	5,000 ohms	300 lamps	Varies from 60 to 112 megohms, according to the number of lamps installed	In dry places, 300 megohms; in damp places, 600 megohms. In plaster work and walls, 1,000 megohms.

RECENT GAS ENGINE DEVELOPMENT.

Writing to the *Electrical Engineer* (N.Y.), Mr. Rudd objects to the method of gas engine regulation by missed explosions. In a 100-volt circuit the variation thus caused is 3½ to 4 volts per cycle. Such engines need a heavy fly-wheel, also a wheel on the armature is needed, and the belts flap about and are noisy and absorb power to the extent of 7 per cent. apart from the loss of about 3 per cent. by the jack shaft. Hence this type of gas engine is limited in its scope.

He describes the Westinghouse gas engine as suitable for incandescent light work. It is governed by regulated charges—not perhaps an economical method—but it is claimed to use about 10½ to 12 cubic feet of natural gas—this must be very rich gas—per B.H.P.-hour in sizes above 20 H.P. This natural gas is, in fact, stated to contain 1,000 B.T.U. per cubic feet, so that the engine produces one B.H.P.-hour for 10,500 to 12,000 heat units. This represents 21·3 to 25·4 efficiency percentage, and as much as 28·7 per cent. has been secured, and Mr. Rudd hopes to see 33⅓ per cent. in the near future.

The jacket water consumed is about 30 lbs. in winter and up to 40 in summer per B.H.P.-hour, and it may be cooled in storage tanks if scarce. A gas engine is thus seen to require as much water apparently as a steam engine, but it does not really do so; the water is heated only, not converted into steam, and does not evaporate so much in cooling down again. In some tests carried out by the writer it was found that of the heat supplied to the engine 5,121 units went into the water, 2,922 went as work and 2,957 units passed away at the exhaust or by radiation. The 650 H.P. engine of the Westinghouse Company is of three-cylinder type and runs at 150 revolutions per minute. This engine is running direct connected to a generator in conjunction with one or two steam engines according to the demand for current. The same company now have in hand designs for a 1,500 B.H.P. gas engine, also of three-cylinder type at 100 revolutions, which is expected to develop a brake horse-power for 8½ cubic feet of natural gas, or, say, 8,500 heat units. Such an engine will run for the equivalent of less than 1 lb. of coal per B.H.P. hour, including banking fires, &c. This is really but half the demands of high-grade steam plant.

The conclusion is that the gas engine has come to stay, and may be looked on as a practical commercial plant.

Already the American Gas Furnace Company have done a good deal in pushing the use of gas for power purposes. They claim naphtha gas to be the cheapest and best fuel for practical use where anywhere from 5,000 to 50,000 cubic feet per day are required, this gas being produced practically with no labour cost, the process being automatic. For large works of course it would be too costly to use such a material, but it stands first in small plants; water and producer gas requiring so much labour.

Good practice shows that 9,000 to 10,000 feet of illuminating gas containing 675 units of heat per foot are equal in heating power to one ton of coal, 140 gallons of crude petroleum, and 50 gallons of naphtha gasified. The price of water or producer gas is but one factor in the calculation, the other is the calorific capacity, which, for producer gas, is not over one-third that of illuminating gas. Every case, of course, requires separate consideration. For large powers cheap gas may be used as the large use will cover labour, but for small powers it is clear that an automatic process even with a more costly fluid such as naphtha must be more economical commercially.

Belgian Chemical Concern.—The Brussels correspondent of the *Financial News* says that the Société Anonyme de Produits Chemiques et Electro-Chemiques has been formed by a syndicate, at the head of which is the Caisse Commerciale, of Brussels, in connection with the Trebertrocknung Gesellschaft, of Cassel. The capital to be raised is for the present 6,000,000 francs in ordinary shares and 4,000,000 francs in debentures, which have already been taken up in Belgium.

SOME NEW FEATURES IN MOTO-VEHICLE DESIGN.*

By THOMAS H. PARKER, M.Inst.E.E.

(*Concluded from page* 482)

Fig. 5 shows the complete car.

Fig. 6 gives a view of a small electric dog-cart to seat four passengers, driven direct by two motors with single reduction by chains, and steered on the broken-axle principle.

Fig. 7.—A small electric dog-cart with double bogie steering, driven by the front wheels, and double reduction through differential gear.

Fig. 8 presents these two small electric cars running round the minimum circle their steering gear will allow. This diagram was obtained by painting the wheels of each vehicle as it turned in

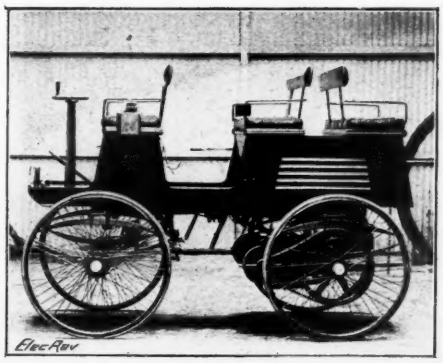


Fig 5

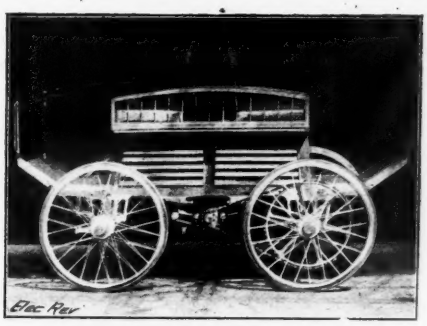


Fig. 6.

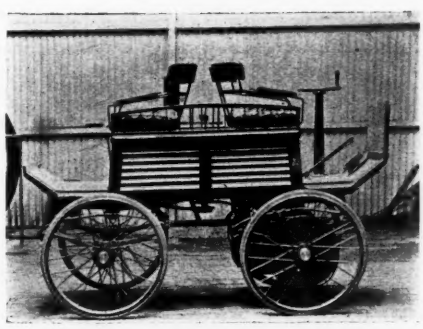


Fig. 7.

the circle. The double bogie car, which is identical in wheel base and gauge with the broken axle car, turns in a circle of 7 feet, and makes two complete rings. It takes exactly the same power to run it in this small circle as it does to run it in a straight line, whilst, it will be observed, the broken-axle car makes four rings, and, when the wheels are turned at an angle of 45°, the minimum circle it will turn in is 18 feet. On looking at the starting point it will be seen that, if a straight line be drawn from the inner to the outer ring on each side, these lines will intercept one another at a distance of 3 feet, which necessitates a sliding movement of the front wheels of 8 inches in that distance. In turning in this circle this car takes twice the power it does when running in a straight line. In

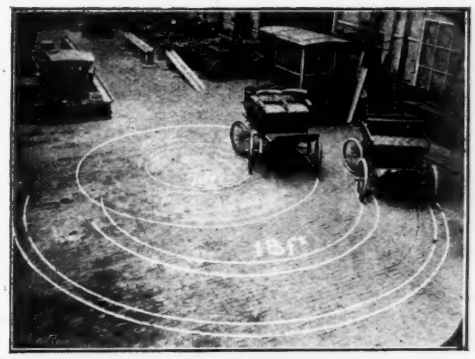


Fig. 8

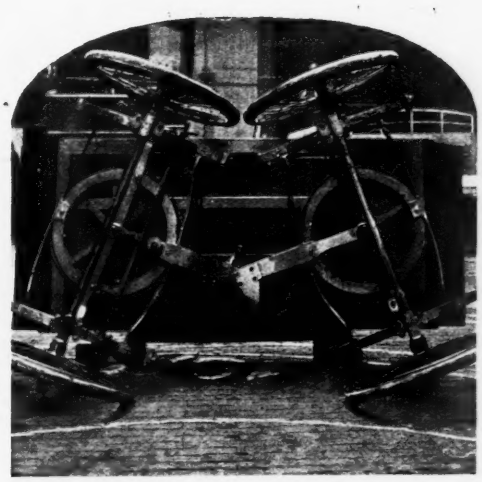


Fig 9.

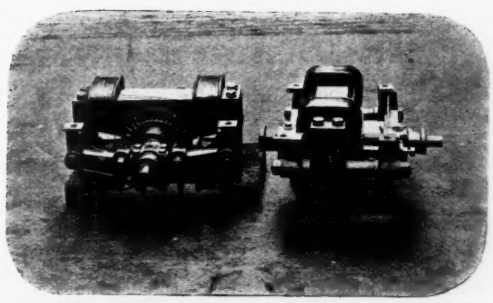


Fig. 10.

consequence of this side movement, or skidding of the front wheels when turning a corner, the rubbers on the front wheels are worn away very much more quickly than they would be in the case of the double bogie car, and the strain on the axles and wheels is much more severe.

Fig. 9 shows a view of the bottom of the small double bogie car with axles turned to their extreme angle.

Fig. 10.—Illustration of the actual motors. These motors develop 2 H.P., each at 560 revolutions per minute, and weigh 2½ cwt. each.

Fig. 11 gives an end elevation of motor and gear in position.

Fig. 12 shows a pair of the author's patent suspension wheels. One of the chief difficulties we had to contend with on the No. 1 car was to obtain a set of wheels that would stand the strain of the rough roads, and the stopping and starting of the motors We tried various kinds made of steel tubes, and also a set made up on the cycle principle, with headed and bent spokes, but neither of these kinds would run more than a week without becoming very dangerous. These difficulties led up to the designing of the wheel which is shown. The method of constructing this wheel is as follows:—

* Abstract of a paper read before the Liverpool Self-Propelled Traffic Association.

A hub of the usual kind is made, having an extra flange on each side. Holes are pierced at equal distances in these flanges, according to the number of spokes required in the wheel. The hubs have, instead of the customary single flange, a double or grooved flange at each end, these flanges having holes equal to one half the number of spokes making up each side of the wheel. The spokes, instead of being constructed with a head and bend threaded separately through the hub flange, are in this case made in such a way, that two are formed

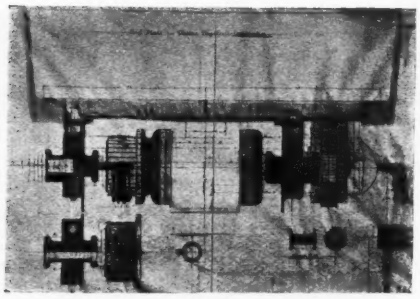


Fig. 11

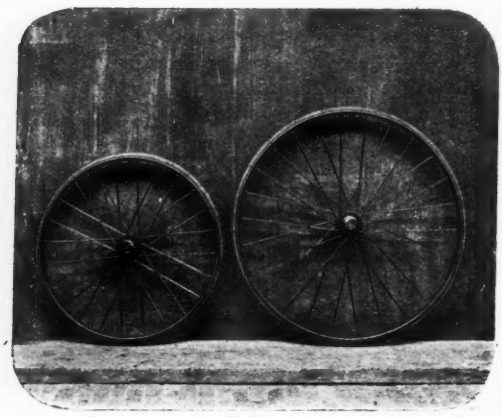


Fig. 12.

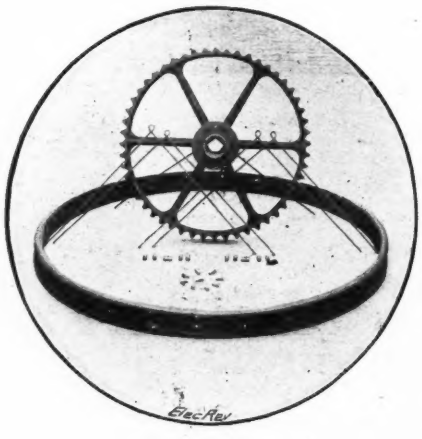


Fig. 13.

by each wire. The wire or rod is placed in a small machine, set at such a gauge as the length of the spokes demands, and by simply turning one lever, the wire or rod is bent at right angles, the bend forming a loop or eye. The eyes of these bent rods or twin spokes are inserted between the double flanges at each end of the hub, and a pin equal, or nearly equal, in diameter to the size of the holes in the flanges is thrust through the holes and through the eye. These pins have a slightly recessed groove in the centre of their length, in which the bent eye of the twin spokes rest, and as tension is applied by means of the nipple coupling to the rim, the pins are held firmly and rigidly in position in the hub flanges, without the necessity of bolting or riveting. No reasonable twisting strain can wrench these spokes from the hub flanges, and under test the wheel conforms to the behaviour of a solid disc of metal. The construction of these wheels admits the casting in one piece of the hubs and sprocket or chain wheels.

Fig. 13 shows combined hub and sprocket wheel, together with spokes, nipples, pins, and rims used in its construction.

Fig. 14 shows true tangeant wheel with hub removed.

We were asked by the London Electric Omnibus Company, Limited, to design and build them an electric omnibus. They had made three or four attempts, under Mr. Ward's direction, but had not been rewarded with much success. I had already had some

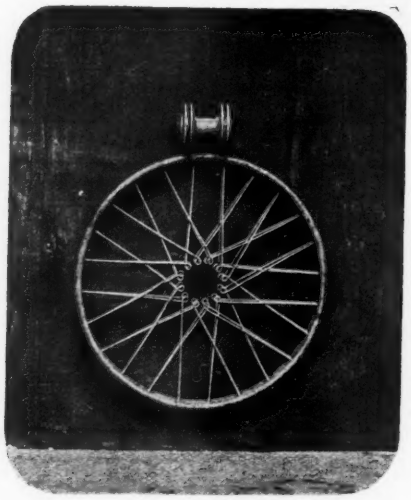


Fig. 14.

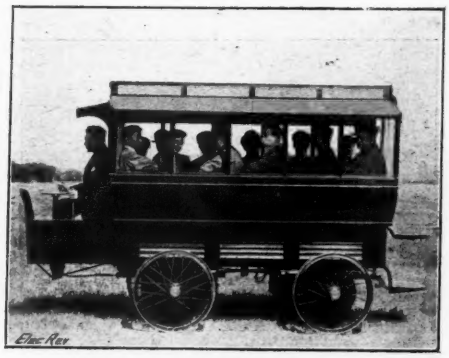


Fig. 15.

experience with the car carrying nine passengers, and I went to London to see Ward's omnibus run. The car that had run so successfully with us weighed 30 cwt. unloaded, and carried nine people. Ward's omnibus weighed, with 24 passengers on, something like 7½ tons. I saw that their difficulty was in the enormous weight, and decided to build one not to exceed 3½ tons loaded with 14 passengers, driver and conductor (fig. 15). This was constructed on the double-bogie principle having the batteries under the seats. It has two motors, one on each bogie, driving all four wheels. To each of the four wheels has been attached a powerful hydraulic brake, working by means of a force pump near the driver's seat. It has only two handles to manipulate it. The vehicle has three speeds forward and one backward, it will turn in its own length, and will run over ordinary roads 25 miles with one charge at a mean speed of 10 miles an hour.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Hissing of the Electric Arc. By Mrs. Ayrton. (Read on March 23rd, 1899.)

There are three ways in which any change that takes place in the electric arc may manifest itself: (1) by giving out sounds of various kinds, or by becoming silent; (2) by changes in its electrical measurements; and (3) by an alteration in the appearance of the crater, the arc, and the carbons. Only two of the many and varied sounds given out by the *direct current open* arc seem to possess much significance—the hum and the hiss—and the causes of these are evidently connected with one another, for the hum never occurs except when

the arc is on the point of hissing, or has just been hissing, although it is quite possible to make an arc hiss and become silent again without any hum being heard either before or after.

It is proposed in the present paper to discuss the arc as it passes from silence to humming, and from humming to hissing; but as the changes that occur when the silent arc begins to hum make themselves perceptible to eye and ear only, and do not sensibly affect the electrical measurements, silent and humming arcs will be included under one head in the portion of the paper dealing with those measurements. It is, however, to the comparatively unexplored region of the direct current *hissing* arc that I desire to particularly direct your attention this evening.

Some of the electrical measurements of the arc burning between two *solid* carbons 11 mm. and 9 mm. in diameter, are shown in fig. 1, in which the curves connect the P.D. between the carbons with the length of the arc for several constant lengths of arc, both silent and

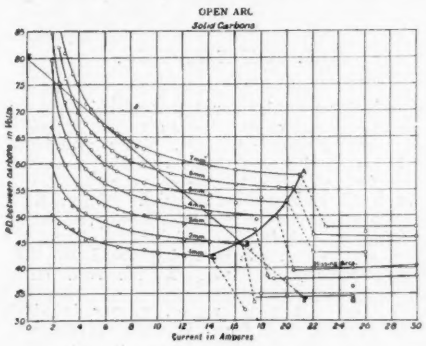


Fig. 1.—Curves connecting P.D. and Current for Constant Lengths of Arc.

Carbons.—Positive, 11 mm.; negative, 9 mm.

hissing. It is important to bear in mind that before each observation was made the current and length of arc were kept *rigorously* constant for a sufficient length of time for the carbons to take their characteristic shape for that particular current and length of arc, and long enough, therefore, for the P.D to have become constant also. Such an arc I propose to call a *normal* arc, as contrasted with one arrived at in a haphazard fashion by suddenly giving the current some particular value and the arc some particular length, and making observations without giving the carbons time to acquire their proper forms.

All the lines to the left of the curve A B C represent silent arcs, while immediately to the right of this curve are dotted lines denoting a period when the arc is in the unstable condition that always divides the silent from the hissing arc; and still further to the right are the lines representing the hissing arc.

As we are only dealing with hissing and humming arcs and with the silent arcs that are near hissing or humming, we need only discuss that part of fig. 1 that is to the right of the line representing, say, 12 amperes, for that part includes all such arcs for each of the constant lengths.

An examination of these curves shows that with the carbons used, and with what I have called the *normal* arc, the following results are met with:—

1. When the length of the arc is constant and the arc is silent, it may be made to hiss by increasing the current sufficiently.
2. The largest current that will maintain a *silent* arc is greater the longer the arc.
3. When the arc begins to hiss the P.D. suddenly falls about 10 volts and the current suddenly rises 2 or 3 amperes.
4. When the current is constant and the arc is silent *shortening* the arc will make it hiss.
5. For the hissing arc the P.D. is constant for a given length of arc whatever the current.

It was Niaudet* who, in 1881, first observed the fall of about 10 volts in the P.D. between the carbons at the moment that hissing began, and although perhaps there is even yet a lingering notion that is only when an arc is short that it can hiss, I find that as far back as 1889 Luggin† showed that however long an arc might be, it would still hiss were the current increased sufficiently.

At the Congress at Chicago in 1893 Prof. Ayrton‡ first drew attention to the region of instability, or, rather, the region of blankness (notice the dotted portion of figs. 1 and 2), corresponding with the impossibility of maintaining any *normal* arc with a particular range of current for each length. At the same time he pointed out in fig. 2, shown at Chicago, that whether the P.D. was descending as the current increased for, say, a 4 mm. *silent* arc, or was ascending for, say, a 0·5 mm. *silent* arc, it became quite constant for wide variations of current with a *hissing* arc.

And, lastly, by a comparison of fig. 2 with fig. 3 he brought out the fact that the largest current that would flow silently with any given length of arc was increased by using thicker carbons; for the carbons in fig. 3 have about twice the diameter of those in fig. 2, and, while the largest silent current for, say, the 2 mm. arc in fig. 2 is 15·5 amperes, that for the same length of arc in fig. 3 is about 49 amperes, or more than three times as great.

Returning now to the subject of the dotted lines in figs. 1, 2 and 3, it is plain that these divide the curves into two perfectly separate parts, governed by different laws. For to the left of the dotted part the lines are all curved, and curved differently according as solid or cored positive carbons are used, showing that with silent

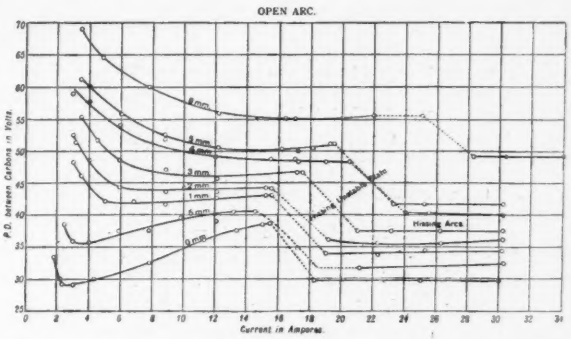


Fig. 2.—Curves connecting P.D. and Current for Constant Lengths of Arc.

Carbons.—Positive, 9 mm. cored.; negative, 8 mm. solid.

arcs the P.D. varies as the current varies, and that the law of variation is different with solid and cored carbons. To the right, on the other hand, the lines are all straight, and more or less parallel to the axis of current, whether the positive carbon is solid or cored, showing that with *hissing* arcs the P.D. is the same for a given length of arc and a given pair of carbons, *whatever* current is flowing, and that this law is true whether the carbons be cored or solid. In fact, some complete and sudden breakdown appears to occur when hissing begins, upsetting all the laws that have governed the arc while it

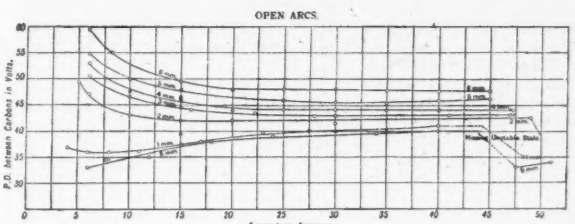


Fig. 3.—Curves connecting P.D. and Current for Constant Lengths of Arc.

Carbons.—Positive, 18 mm., cored; negative, 15 mm., solid.

was silent, and bringing the behaviour of cored and solid carbons into accord.

Thus, our subject divides itself quite naturally into two distinct portions, the one dealing with the arc when the breakdown is imminent, but before it has actually occurred—dealing, that is to say, with the points at which the current is the largest that will flow silently—the *hissing points*, as I shall call them; and the other dealing with the arc after the breakdown has occurred, and when, therefore, the arc is really hissing.

On examination of fig. 1, the points of which were obtained experimentally with much care, it is seen that the hissing points lie well on the curve, A B C, the equation to which I have shown elsewhere* to be

$$v = 40\cdot05 + \frac{2\cdot91\,a - 29\cdot02}{10\cdot54 - 0\cdot416\,a} \quad . \quad . \quad . \quad . \quad (1)$$

where v is the P.D. between the carbons in volts, and a is the largest silent current in amperes. Or, expressing the P.D. in terms of l, the length of the arc in millimetres, instead of in terms of the current at the hissing points, we have

$$v = 40\cdot05 + 2\cdot49\,l \quad . \quad . \quad . \quad . \quad (2)$$

which shows that at the hissing points any given increase in the length of the arc causes an increase in the P.D. between the carbons that is simply proportional to the increase of length. That is to say, for every millimetre that is added to the length of the arc, 2·49 volts is added to the P.D. between the carbons at the hissing point.

From the above two equations I deduced the third, viz.:—

$$l = \frac{1\cdot17\,a - 11\cdot66}{10\cdot54 - 0\cdot416\,a} \quad . \quad . \quad . \quad . \quad (3)$$

and pointed out that, since l was infinite when

$$10\cdot54 - 0\cdot416\,a = 0, \text{ or when } a = 25\cdot3 \text{ amperes},$$

no current greater than 25·3 amperes could maintain a normal *silent*

* *La Lumière Electrique*, 1881, Vol. iii., p. 287.
† *Wien Sitzungsberichte*, 1889, Vol. xcviii., p. 1,192.
‡ The *Electrician*, 1895, Vol. xxxiv., pp. 336 7.

* The *Electrician*, 1896, Vol. xxxvi, p. 541.

arc, however long it might be made with the particular carbons used. Hence we may gather that for each pair of carbons the current that will sustain a normal silent arc has a maximum value, and that any current greater than this will make the arc hiss, however long it may be.

To turn, now, to the arc when hissing has actually begun. It has already been shown than when the arc is hissing, the P.D. between the carbons is constant for any given length of arc, and is therefore independent of the current; but no law has yet been given connecting the P.D. between the carbons with the length of the arc when hissing. This can now be found from fig. 1, by plotting the mean P.D. between the carbons for each length of arc when it was hissing, with the corresponding lengths of arc. In this way we get a straight line, the equation to which is

$$v = 29\cdot25 + 2\cdot75\,l \quad . \quad . \quad . \quad . \qquad (4)$$

How far equation (4) really sums up the facts may be seen from Table I, which gives the mean value of the observed P.D. between the carbons for each length of hissing arc, the P.D. calculated from equation (4), and the difference between the two.

Table I.—Hissing Arcs.

Mean P.D. between carbons for different lengths of arc compared with same P.D. calculated from equation (4).

Carbons: positive, 11 mm. solid; negative, 9 mm. solid.

Length of arc in millimetres.	Mean P.D. between carbons in volts.	P.D. calculated from equation (4).	Difference in volts.
1	32	32·0	0
2	34·4	34·75	−0·35
3	37·8	37·5	+0·3
4	40·0	40·25	−0·25
5	43·0	43·0	0
6	46·5	45·75	+0·75
7	48·0	48·5	−0·5

Equation (4) shows that with the hissing as with the silent arc, a straight line law connects the P.D. between the carbons with the length of the arc.

There is, however, this vast difference between the law for silent and that for hissing arcs, viz., that, for silent arcs, the law only holds for constant currents or for the currents at the hissing points, whereas for hissing arcs it holds *whatever the current may be*. Thus, while for silent arcs the constants which correspond with the terms 29·25 and 2·75 in equation (4) are constant only for each separate current, and change when the current changes, with *hissing* arcs they remain the same *whatever* the value of the current may be. For instance, the equation equivalent to equation (4) for a normal silent arc with a current of 4 amperes is

$$v = 41\cdot79 + 4\cdot71\,l,$$

and with a current of 12 amperes it is

$$v = 39\cdot85 + 2\cdot95\,l;$$

but with the hissing arc the equation is

$$v = 29\cdot25 + 2\cdot75\,l,$$

whether the current be one of 20 amperes or of 50, and whether the arc be normal or not.

This brings me to the reason for the great importance of distinguishing between arcs that are normal and those that are not. We have seen that, with normal arcs of any given length, hissing only starts when all the silent arcs have been used up, as it were; that is to say, when the current is *greater* than it can be with any silent arc of the same length. But with a *non*-normal arc of 2 mm. I have been able to produce hissing with a current of 11 amperes, and to have a silent arc burning with a current of 28 amperes, the same carbons being used in each case. This apparent anomally will be fully explained later, when we go into the causes that produce hissing.

We are now in a position to find the law connecting the length of the arc with the change that takes place in the P.D. between the carbons when hissing begins. For if we call v the P.D. between the carbons at the *hissing point* with any given length of arc, l, and v′ the same P.D. when the same length of arc is hissing, then from equations (2) and (4) we get—

$$v - v' = 10\cdot8 - 0\cdot26\,l \quad . \quad . \quad . \quad . \qquad (5)$$

which shows that the longer the arc the less does the P.D. between the carbons diminish when it changes from silence to hissing.

In 1889, Luggin* found, by measuring the fall of potential between each carbon and the arc, that the principal part of the diminution of P.D. caused by hissing took place at the junction of the positive carbon and the arc. About three year's ago, not then having come across any account of Luggin's experiments, I made some of the same sort myself and obtained the same result. I used two solid Apostle carbons 11 mm. and 9 mm. in diameter, and the third carbon for placing in the arc was 3 mm. in diameter. This last was somewhat thick, but it burnt well to a point in the arc, and thinner carbons burnt away too rapidly with the current I used—25 amperes—to give good measurements. The P.D. between the positive carbon and the arc was found by placing the third carbon in the arc as close as possible to the positive carbon, and measuring the P.D. between the two with a very high resistance voltmeter. This was easily done when the arc was hissing, but was impossible when the largest silent current was flowing, for then the mere insertion of the third carbon was sufficient to make the arc hiss. Accordingly the P.D. between the positive carbon and the arc when the largest *silent* current was flowing has had to be calculated from the formula I gave at the meeting of the British Association* last year for calculating that P.D. with *any* silent current, viz.:—

$$v = 31\cdot28 + \frac{9 + 3\cdot1\,l}{A}.$$

(To be continued.)

* *Wien Sitzungsberichte*, 1889, Vol. xcviii. p. 1,192.

ELECTRIC TRACTION AND ITS APPLICATION TO SUBURBAN AND METROPOLITAN RAILWAYS.†

By PHILIP DAWSON.

There is no longer room for doubt that electricity is the one pre-eminently successful motive power for tramways. This is proved by the rapid growth of electric traction. The words "experimental line" have fallen out of use, yet it is only a few years ago that those who ventured to foretell that the trolley system would be generally introduced into this country were ridiculed. There is no country in which electric traction is advancing more rapidly, and in which finer plants are being installed than in Great Britain. The day is not far off when horses and steam will have disappeared from the streets as far as tramways are concerned, and when the horse 'bus as a competitor will be no longer known.

The problem of greatest importance, however, in which electric traction will be a principal factor, is the rapid transportation of large crowds from and to their business in our cities. The object of this paper is to investigate in a general way the special requirements of this service, and to demonstrate the special adaptability of electric traction to it.

It is evident that the only solution of rapid transit lies in railways which must be either overhead or underground, and of both London possesses a greater mileage than any other town in the world. The factor of initial expenditure must restrict the number of tracks available for the up and down traffic.

The stopping places on such lines must of necessity not be far apart, and to diminish the crowds on the platforms, and to increase the number of passengers, the trains must follow each other with the greatest possible frequency. Consequently the average speed of the trains must be increased as much as possible, without unduly diminishing the distance between two consecutive trains, which would be dangerous.

Steam locomotives have probably reached their approximate maximum development, and the results so far obtained with them for the class of traffic in question are far from satisfactory. They do not get up speed rapidly, owing chiefly to the torque on the driving axles constantly varying in consequence of the reciprocating motion of the pistons. They are not economical, as their fuel consumption is practically the same, whether they are exerting their fullest power, coasting or standing still, and their maintenance is very costly.

There is a commercial limit as far as distance is concerned beyond which transmitting power electrically will not pay. But that limit varies with each case, and cannot be ascertained except by the most careful calculation after all the conditions that obtain have been minutely examined. England was the first country to introduce electric traction on railways, both underground and overhead, as instanced by the City and South London and Liverpool overhead electric railways. But to prove commercially that very much heavier traffic could be handled, that much greater distances could be traversed, and to develop on a large scale the necessary machinery was again left to America, and hence the necessity of being practically confined to American experience and examples in this paper.

There are practically three methods of handling electrically the traffic on a railway, namely:—

1. By locomotives or motor cars hauling a train of trailer cars.
2. By independent motor cars.
3. By a set of independent motor cars formed into a train and handled from the front car or from a so-called controller car. Each car, however, can be separated from the train, and it then becomes an independent motor car.

As regards the supply of the necessary current for the motors, there are three distinct methods:—

1. By accumulators or storage batteries, which may be carried either on the motor car or locomotive, or on a tender.
2. By having a car containing a stationary engine, dynamo, and boiler, which supplies the necessary current to the motors on the cars comprising the train of which it is part, and as proposed by W. Heilmann.
3. By continuous or multiphase current supplied directly from a generating station, or from a sub-station which, in its turn, gets its supply of energy from the main station, the current being distributed either in the form of direct or polyphase to conductors running along the lines, and from which the power is supplied through sliding contacts on the cars to the motors.

The two former methods, as far as this paper is concerned, will not be discussed, as sufficient data are not available to justify their being considered.

* Report of the British Association, 1898, p. 805.
† Society of Arts, March 22nd.

The system of transmission of energy to the motors by means of conductors laid along the track, will therefore alone be considered.

This method allows of several variations as far as the generation and distribution of power is concerned, amongst which the chief may be set down as follows:—

(*a*) One continuous current generating station supplying current direct to contact rail. Where drop in pressure owing to distance becomes excessive, a negative "booster" may be used— it serves, so to speak, to pump back the current to the station, and is self-regulating, not taking at any period more power than is actually required to pump the current back. Should there be one or two lines too long to enable them to be worked this way, polyphase high tension generators should supply the power to one or more sub-stations along the line, as may be found necessary, in which rotary converters are located, which transform the current back into continuous. The polyphase generators to be driven by continuous current motors in the generating station. As an example of such a station, the new Dublin tramway power house may be taken.

(*b*) One central station generating continuous current with sub-stations in which accumulators are located along the road, and which are charged by means of a booster and special cables. As an example of this system, the Leeds tramways may be taken as designed by, and carried out by, the late lamented Dr. John Hopkinson.

(*c*) A series of stations, as described under (*a*) and (*b*), situated at various distances and connected together one with the other. As an example of this, the tramways and light railways in and round Boston, Mass., may be taken, owned by the Boston Elevated Railway Company, which has absorbed the well-known West End Company.

Data of Boston Elevated Railway.

Track miles operated	305
Number of cars	2,648
Car miles run during 1898	29,787,000
Passengers carried during 1898...	172,764,300
Number of power stations	5
Total capacity of power stations in kilowatts...	16,100
Total rated indicated horse-power of engines...	24,000

(*d*) A power station generating polyphase currents, which, by means of static step-up transformers, are transmitted at tensions which run from 2,500 to 40,000 volts to sub-stations where static step-down transformers reduce them to pressures of 300 to 350 volts, the current at this pressure enters rotary transformers, which deliver direct current at 500 to 550 volts to the line. As an example of this later system, the Central London Railway, which is now under construction, may be mentioned.

(*e*) A three-wire system with continuous current, the rails or return forming the neutral wire. This has been tried and found wanting, and the engineers of the Central London Railway most carefully investigated its possibility, and decided in favour of polyphase transmission and rotary converters, and rightly so.

From careful calculations and the investigation of what has been done both in Europe and America, there is no getting behind the fact that for any power station which will exceed 4,000 kilowatts in capacity, the polyphase system is nearly certain to prove commercially the only admissible one. This statement is upheld by such an authority as Mr. H. F. Parshall, M.I.C.E. It is evident that in the particular cases at present under consideration (suburban and metropolitan communication) more than 4,000 kilowatts will be under consideration, and therefore nothing, as far as the power station and transmission is concerned, but polyphase currents will be considered.

There are two distinct varieties of service to be catered for One that on a system like the Metropolitan and District, where the stops are frequent and the runs short; the other the case of longer distance lines with few stops. In the present paper it is only proposed to consider the first variety. In this case the use of polyphase motors need not be considered, as for work entailing frequent stopping and starting they have not up to date proved satisfactory.

A short examination of the importance of rapid acceleration on lines having stopping places at short intervals is interesting. Practical experience with electrically-driven motor cars, or locomotives on the experimental track of the General Electric Company, at Schenectady, has proved that it is perfectly feasible to attain a speed of 30 miles an hour 10 seconds after starting from a standstill. Assuming a level track, and that during 65 seconds the current is cut off and the train allowed to coast, that the brakes are then put on, the train will be brought to a standstill 15 seconds later, and the total time from start to stop will be 90 seconds. Under these conditions it will be found that the average speed will have been 23·16 miles an hour, and that the total distance run will be about ·55 of a mile. Assuming that instead of attaining the 30 miles an hour in 10 seconds, it took 30 seconds, and that this full speed of 30 miles an hour was kept up for 40 seconds longer, and the brakes then put on, the train would be brought to a standstill in 90 seconds, and the average speed would work out at 21·66 miles an hour, or an average speed of about 10 per cent. less than in the previous case, the consumption of power, however, being much greater.

It is evident that the most important point is to attain a high average speed, and to keep the maximum speed attained as low as possible, as by so doing less power is required in braking the train and also less power is required to run the train. The time between the moment when the maximum speed is attained and when the brakes are put on, should be at least from four to six times that required for stopping the train, so as to allow for errors in judgment on the part of the driver, and also to enable him to make up lost time. On the Manhattan Elevated Railway, in New York, the trains, which are drawn by steam locomotives, take 20 seconds to attain a speed of 14 miles an hour, or less than half the speed in double the time as compared with electric traction just mentioned.

A much larger current will be required to attain a rapid acceleration than to attain a slow one, but the current will be required during a much shorter time, and the total energy supplied will be less in the case of rapid than of slow acceleration. This fact must not be lost sight of when calculating the feeders for such a system, and the train service should be arranged in such a way that as few trains as possible start together. Furthermore, the more rapid the acceleration required the larger will the motors have to be, and therefore there will be a limit, above which it will not be advantageous to push the rapidity of acceleration. In new tunnel lines, such as are now being constructed all over London, it will be evident that it is an advantage to have the stations built with a down grade for the trains to start, so as to help the motors and reduce the current required at starting, and that similarly it will be an advantage to have an up-grade when nearing a station, so as to reduce the amount of power required in braking. By properly choosing these gradients, it is found that a total economy of from 40 to 50 per cent. in the total power required by a train may be made. According to Mr. Potter's tests, it was found that during acceleration an average power of 32 amperes per ton of weight of train was required.

With a complete train composed of one motor car and two passenger cars, weighing, complete, 148,000 lbs., a maximum horizontal effort of 9,750 lbs. was required in acceleration, the maximum current was 780 amperes at 500 volts, the maximum speed attained was 32 miles an hour, and the time taken to attain the speed was 34 seconds, the motor car being equipped with two 200-horse-power motors.

Metropolitan Elevated, Chicago.

Number of cars in train.	Average speed (not including stops) in miles per hour.	Average current (not including stops) in amperes.	Board of Trade units delivered at switchboard per ton mile.
4	14·4	148·7	·050
4	14	153·2	·053
4	14·5	151·8	·050
3	14·7	137·4	·063
3	15·1	135·6	·058
2	15·3	90·1	·058
2	16·8	106·6	·059
4	12·2	101·1	·042

Railway company.	No. of cars.	Weight of trains in lbs.	Tractive effort per ton.				Maximum speed in miles per hour.	Distance run.
			Maximum for given time.		Average for total time.			
			Sec.	Lbs.	Sec.	Lbs.		Feet.
Metropolitan Elevated, Chicago ...	2	88,000	10	177	40	107	34·8	1,020
Lake Street Elevated, Chicago ...	2	88,000	10	135	40	84	27·6	870
Alley Elevated Chicago ...	3	144,000	10	135	40	98	28·6	840
Illinois Central, Chicago	4	300,000	10	95	40	79	25·60	750
Manhattan Elevated, New York...	4	190,000	10	88	40	67	21·00	615

In another case, with a train composed of one motor car, equipped with two 125-horse-power motors and one trailer car, the total weight of train being 103,000 lbs., a maximum speed of 31 miles an hour was attained in 37 seconds, the maximum current being 500 amperes, and the maximum horizontal effort required to attain acceleration 5,640 lbs. In a series of tests made on the Nantasket Beach line it was found that with a heavy motor car, 51 feet in length overall, carrying 100 passengers, weighing 31 tons, on an average distance of 2,980 feet between stations, a maximum speed of 40 miles an hour was attained, the average speed being 18 miles per hour, and the power required was 0·098 Board of Trade units per ton mile.

(*To be continued.*)

The Telephone Question.—The Liverpool Chamber of Commerce has asked the Huddersfield Chamber to resist the proposals of the Government in regard to the municipalisation of telephones, on the ground that a multiplicity of systems would be detrimental to traders. Mr. T. H. Moore, speaking at a recent meeting of the Huddersfield Chamber, said that the letter touched a weak spot in Mr. Hanbury's Bill. Supposing Huddersfield had an independent telephone system, and Bradford and Halifax each refused to have one, the telephones would be worthless to traders in those towns for intercommunication. The solution of the difficulty would be for the Government to take over the whole system. The Chamber took the same view, and decided simply to acknowledge the receipt of the communication.

THE POST OFFICE AND TELEPHONY.

By S. ALFRED VARLEY.

The inefficiency of the telephone service and the high rates charged, which formed the subject of a debate in the House of Commons on April 1st, 1898, seems to me to be a practical illustration of the unwisdom of having made telephony a Post Office monopoly. The effect of all monopolies is to create privileged classes, who make large profits for themselves at the general expense of the community. The introduction of railways, the invention of the electric telegraph, and also that of the telephone, have each of them introduced new eras by the increased facilities they have afforded for commercial enterprise, and the telephone deserved to have been regarded as differing as much from the ordinary electric telegraph as the electric telegraph itself differed from the mechanical telegraphs which it superseded.

For the privilege of establishing telephonic exchanges, the Telephone Company have to pay to the Post Office 10 per cent. *not* of their profits, but of their gross receipts, and when their lease expires, which it will in 1911, it will not be renewed. Under these circumstances, who can blame the Telephone Company for making what little hay they can whilst the sun continues to shine. Imagine for a moment that the Government of the day had treated railway enterprise similarly as they have done telephony, granting them short leases only, and compelling them to pay for the privilege of carrying goods and passengers 10 per cent. out of their gross receipts. Would it, I ask, have been possible for the railway companies to have given us that cheap and efficient service which we at present enjoy? Now, if telephony had been allowed to have been developed in a natural way, instead of being swooped down upon by the Post Office, the Bell Telephone Company, which was not over-capitalised, being aware that so soon as their patents expired (1890) competing companies would certainly be formed, they would naturally in self-defence have strained every nerve to give the public a cheap and efficient service, with a view to holding their own, and keeping rivals out of the field.

If the history of the pioneering of telephony ever be truly written, it will be found that the Post Office has been the Mephistopheles of the piece, and that at their doors lies the responsibility of its unhealthy development and the over capitalisation of the National Telephone Company in the first instance; astute financiers making large hauls, by taking advantage of the conditions of things created by the Post Office, and barristers, as well as special scientific experts, profiting by the professional work it gave rise to.

Ever since telegraphy has been a Government monopoly, the chariot wheels of the Post Office have driven heavily, and Postmaster-Generals, as well as British taxpayers, have reason to regret the introduction of protectionism in an internal industry of the country by a John Bright-Gladstonian Cabinet.

Now, the sole object I have in view in writing this article, is to bring home to the British public, if I can, the evil consequences of the un-English retrograde policy of converting applied science into a Government trading monopoly, and my hope is that I may be the means of awakening the Legislature to the subject with a view to retracing its steps, and re-introducing free trade in so important an internal industry of the country as is that of applied electricity.

Now I should like to urge upon the attention of those members of Parliament who have the interests of the United Kingdom really at heart, that if they could obtain for the country the same free trade for telephony, telegraphy, and the carriage of letters, which does already exist in the case of the carriage of parcels, that they would not only inaugurate a great reform, but they would also remove an incubus from the shoulders of the Government.

The relative greatness of Great Britain is largely due to the fact that British Governments of the past have simply governed, leaving to private enterprise what the grandmotherly Governments of some other countries would consider it their prerogative to initiate. I know it is sometimes, and truly said, that trade follows the flag, but private enterprise invariably shows the way, and our success as colonists arises in no small degree from the fact that the mission of the British flag has been hitherto simply the securing unrestricted freedom for the further extension of private enterprise.

The abolition of the corn laws in 1846 had the effect of stimulating inventive and constructive genius, and during the beneficent reign of Her Majesty the Queen, the country has been indebted for its increase of wealth and general prosperity to mechanical engineers and practical scientists in a greater degree, than to any other class of men; but if the more or less one-sided free trade we enjoy has on the whole been a blessing, freedom from interference in our internal industries is of greater importance to us, and for the reason that as all nations are more or less complete systems, little worlds in themselves, liberty to manufacture and to trade in the country where we dwell affects us more directly than liberty to trade outside our shores, and consequently trading restrictions imposed by our own Government are more detrimental to the nation as a whole than any restrictions a foreign Government may impose upon our doing business with them.

In the year 1878 an American gentleman of the name of Churchill was sent over to this country to obtain dynamo-electric information. Among others he called upon was myself, and I learned from him that at a meeting of American capitalists the following conclusions had been arrived at (1) that a great industry would in all probability grow out of the discovery of the dynamo principle, and (2) that in respect to dynamo-electric knowledge, America was behind England, France, and Germany, and he further informed me that these capitalists had subscribed money between them, and commissioned him to visit Europe with a view to collecting all the information he could. But if in 1878 America was in the rear of Europe in respect to dynamo-electric knowledge, she is no longer so now, and yet it was England that led the way in telegraphy. It was English genius and English capital which bridged the Atlantic. The first to discover the dynamo principle was myself, and the first self-exciting dynamo made, and which is now in the Patent Museum, South Kensington, was designed and constructed by me early in September, 1866, but the introduction of protectionism in so important an industry as telegraphy, has given the Postal executive a grip hold of applied electricity, and has enabled them to crush practically out of existence pioneers in telegraphy and applied electricity, such, for example, as myself. English telegraph enterprise no longer exists, and America, which 20 years ago was electrically in the rear of this country, is now England's teacher. At the present time not only does she take premier rank in dynamo-electric developments, but practically all the telegraphic advances which have been made since the passage of the Telegraph Act, have originated from American genius, and Mr. Preece in his presidential address delivered before the Electrical Engineers in 1893, takes credit to himself for patronising American advances, and he tells us that American inventors look to the Post Office to improve their inventions, but he omits to state that the developing American ideas in the Government workshops, and the adaptation of them to English requirements, is carried out at the expense of the British taxpayer, who also pays—presumably on the recommendation of the Postal Engineer-in-Chief—large sums of money for patent rights.

Among those who gave evidence before the Select Committee of Inquiry on Telephony of 1898, was Mr. Preece, who, as might have been expected, is wholly in favour of the Post Office taking telephony into their own hands. The idea seems to be that the Postal Department can do telephonic work more efficiently and at lower rates than private enterprise. Now, if this be so, why should the Post Office need to trade with loaded dice? I had the pleasure of discussing this matter with the late Lord Playfair shortly after he had ceased to be Postmaster-General, when I pointed out that if the Postal Department with their numerous agencies, in shape of post offices, could not hold their own in competition with private enterprise, then it was not to the true interest of the country that the Government should have acquired the telegraphs. I also expressed the opinion that they could well have held their own, and that whatever competition occurred, would certainly be for the benefit of the country, and, as I believed, it would in the long run be beneficial to the Post Office also. Lord Playfair, I was glad

to find, held similar views to those I had given utterance to, and on the subject of the telegraph monopoly, he expressed himself most emphatically, saying, "There never was a greater mistake than the making telegraphs a monopoly."

It is, however, a mistake to suppose that a Government department can carry out electrical work either better or more economically than private enterprise. I proceed to give evidence which bears on this. As is well known, the Marquis of Salisbury was a pioneer in applying electrical energy to domestic lighting and the transmission of power, and under Lord Salisbury's instructions the work was carried out mainly by one of his permanent staff, the late Mr. Shillito. Now, I myself resided at Hatfield early in the seventies, and up to early in the eighties, during which time the electric lighting was installed at Hatfield House, and, in a friendly way, from time to time I both gave advice and caution to Mr. Shillito, who frequently consulted me. On one occasion he told me they wanted some simple electrical apparatus for signalling from Lord Salisbury's London residence to the stables, and I showed him a piece of apparatus designed by me to meet a special railway want. This apparatus was approved of by the Marquis of Salisbury, and the Post Office was applied to in reference to erecting and maintaining a few short lengths of overhead wires, but the price demanded by the Post Office was so high as to be considered prohibitory, I then advised Mr. Shillito to apply to a private contractor, which was done. The contractor's price was less than half that of the Post Office, and the work was put into his hands, and for aught I know to contrary, these wires are being maintained at the present time by the contractor who erected them.

At the present time the largest users of the telegraph are betting men, bookmakers, financial speculators and Stock Exchange gamblers, and, in a less degree, merchants, commercial corporations, and business men, and thanks to the telegraph monopoly, these messages are forwarded at a heavy annual loss to the British taxpayer. Now, if the Post Office be allowed to enter into competition with the Telephone Company as is now proposed, and to make a large reduction in the charges at the same time, it requires but little prescience to foresee that history will repeat itself, and that the present annual loss to the taxpayers on the telegraph account will be largely swelled by that of telephony. The £2,000,000 asked for is, of course, only a first instalment, the Post Office will never be allowed to confiscate the property of the National Telephone Company by starving them out of existence at the expense of the country's money, and therefore in the long run they will have to buy them up; and I see by the daily papers that the money required to do this, and to carry out the general re-construction of the telephone plant, recognised as being necessary, is estimated to amount to between 8 to 12 millions of pounds.

The telephone itself is becoming an everyday necessity to business men, and therefore every facility should be given for its healthy extension, short of taxing the country as a whole, for the advantage of the users of it, and it seems to me that the only way of meeting the legitimate demands of commercial men is to do away with the monopoly which the Post Office at present enjoys, and let them trade on equal terms with private enterprise; matters will then gradually right themselves in a natural way.

In the interests of the country the Government constructs warships and manufactures war material, but it does not interfere with private enterprise in the matter of ship building and gun making, and why, I ask, should applied electricity be placed on a different footing to that of every other industry of the country, and why should the power be given to the executive of a Government department to crush out of existence pioneers who have consecrated their lives helping to build up the edifice of applied electricity?

(To be continued.)

TEMPERATURE COEFFICIENT OF THE RESISTANCE OF COPPER WIRES.

We have received from Messrs. Clark, Forde & Taylor a set of tables of the comparative values of the resistance of copper wire at different temperatures. The authors have found that the table commonly used, constructed from the data of Mathiessen's experiments, does not represent the facts in the case of the very pure copper wire now obtainable, and they have made fresh experiments on samples of copper wire supplied to them by the Telegraph Construction and Maintenance Company. The results obtained are plotted on a diagram, and a curve is drawn representing the law deduced from them. They find that the ratio of the resistances at 32° and 100° F. to be greater by ·8 per cent. than did Mathiessen. Two tables of coefficients and a table of logarithms are given, and the whole is bound in a very neat and convenient form for reference.

The proceeding was as follows:—The samples of wire laid on ebonite cylinders and connected to solid copper terminals were placed in paraffin oil, in an outer bath of ice or water, and the resistances measured. The temperatures were taken with carefully-verified thermometers. Measurements were taken at 32° F., at a series of temperatures lying between 43° and 63° F., at several temperatures near 75° F., and at several near 100° F. The coefficients, a b, of an arbitrary parabolic formula

$$\frac{R}{R_{32}} = 1 + a\,(t - 32) + b\,(t - 32)^2$$

were calculated to give the best agreement with the experimental data, with the following result:—

$$\frac{R}{R_{32}} = 1 + \cdot0023708\,(t - 32) + \cdot00000034548\,(t - 32)^2$$

where t is the temperature (F.) lying between 32° and 100°, R the resistance at t, and R_{32} the resistance at 32° F. The form of this expression is perfectly arbitrary, and has no justification excepting so far as it fits the experimental results. To show how close this is, we give a comparative table of the figures of this and other formulæ:—

Value of the resistance at	32°.	52°.	72°.	102°.
A. Taken from the experimental results plotted on Clark, Forde & Taylor's diagram	1·0000	1·0472	1·0955	1·1677
B. Calculated from Clark, Forde & Taylor's parabolic law, and tabulated by them.	1·0000	1·0475	1·0954	1·1679
C. Calculated from a straight line law passing through the plotted values at 32° and 72°	1·0000	1·0477	1·0955	1·1671
D. Calculated from a logarithmic or compound interest law from the values at 32° and 72°, giving ·228 per cent. per degree F.	1·0000	1·0468	1·0955	1·1731
E. Similar to D, but calculated from the values at 32° and 100°, giving ·222 per cent. per degree F.	1·0000	1·0453	1·0926	1·1677

The set of figures, B, obtained from the author's formula, gives the closest approximation to the experimental results, differing at the most by ·12° F. The straight line law, set C, differs only by ·2° F., and is amply good enough for cable work. Sets D and E are much inferior. We have introduced them only because a law of this kind is given in many text-books, and has been largely used. It has no justification in fact.

It is clear that these tables of Messrs. Clark, Forde and Taylor, should immediately replace Mathiessen's table where it is still used, but if there is any one place more than another where the platinum thermometric scale should replace the scale of the mercurial thermometer, it is in a cable factory. These reduction tables then disappear, and the resistance of a pure copper wire measures its own temperature directly.

The City Company's Pressure.—The City of London Electric Lighting Company, Limited, is giving notice that the standard pressure in the whole of the company's area, both in the City of London and Southwark, will shortly be increased to 200 volts on each side of the company's three-wire network. Consequently all new installations must be arranged for this pressure, otherwise they will not be connected to the company's mains.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

5,416. "Improvements in spring break switches for electric currents." J. J. Walklate. Dated March 13th.

5,464. "Means for rendering electrically conductive incandescence bodies which conduct only when their temperature is raised and apparatus therefor." P. Schabf. Dated March 13th.

5,468. "Improvements in the electro-deposition of metals." A. Zimmermann. (Dr. Courant, Germany.) Dated March 13th.

5,486. "Improvements in electric incandescence lamps." G. C. Allingham and W. Fennell. Dated March 14th.

5,514. "Improved electric light apparatus for taking photographic portraits." G. W. Morgan. Dated March 14th.

5,518. "Improvements in electric spark apparatus." T. B. Kinraide. Dated March 14th. (*Complete.*)

5,519. "Improvements in electric break apparatus." T. B. Kinraide. Dated March 14th. (*Complete.*)

5,545. "Improvements in induction motors for alternating electric current circuits." The British Thomson-Houston Company, Limited. (E. W. Rice, jun., and C. P. Steinmetz, United States.) Dated March 14th. (*Complete.*)

5,546. "Improvements in induction motors for alternating electric current circuits." The British Thomson - Houston Company, Limited. (E. W. Rice, jun., and C. P. Steinmetz, United States.) Dated March 14th. (*Complete.*)

5,547. "Improvements in devices for changing the frequency of alternating currents in systems of electrical distribution." The British Thomson Houston Company, Limited. (C. P. Steinmetz, United States.) Dated March 14th. (*Complete.*)

5,548. "Improvements in devices for changing the frequency of alternating currents in systems of electrical distribution." The British Thomson-Houston Company, Limited. (C. P. Steinmetz, United States.) Dated March 14th. (*Complete.*)

5,549. "Improvements in systems of electrical distribution." The British Thomson - Houston Company, Limited. (C. P. Steinmetz, United States.) Dated March 14th. (*Complete.*)

5,550. "Improvements in self-starting alternating electric current motors." The British Thomson-Houston Company, Limited. (C. P. Steinmetz and E. J. Berg, United States.) Dated March 14th. (*Complete.*)

5,551. "Improvements in devices for starting alternating electric current motors." The British Thomson - Houston Company, Limited. (C. P. Steinmetz and E. J. Berg, United States.) Dated March 14th. (*Complete.*)

5,570. "Improvements in closed conduits for electric railways and trolleys therefor." A. M. Clark. (The Campbell Electric Traction Company, United States). Dated March 14th. (*Complete.*)

5,572. "Improvements in insulators for carrying electric line wires." G. Hullstrung. Dated March 14th. (*Complete.*)

5,576. "Improvements in automatic systems of preventing collisions on electric railways." C. F. Bancroft and P. F. Sullivan. Dated March 14th. (*Complete.*)

5,601. "Improvements in travelling cranes driven by electric power." J. Adamson and D. Adamson. Dated March 15th.

5,619. "Improvements in or applicable to galvanic batteries." F. E. Singer. Dated March 15th. (*Complete.*)

5,634. "An improved lampholder and shade-attaching device for incandescent electric lamps." R. Rough. (R. C. G. Clark, South African Republic.) Dated March 15th.

5,647. "Improvements in secondary batteries." H. S. Gladstone and E. J. Beckett. Dated March 15th.

5,657. "Improvements in apparatus employed in wireless telegraphy." G. Marconi and The Wireless Telegraph and Signal Co., Ltd. Dated March 15th.

5,665. "Improvements in apparatus for electrically transmitting orders, signals, or indications from one place to another." A. U. Alcock. Dated March 15th.

5,672. "Improvements in electric switches." R. B. Roberts. Dated March 15th.

5,680. "Improvements in and connected with incandescent electric lamps." J. F. Stanley, Earl Russell. Dated March 16th.

5,685. "An improvement in arc lamps especially for cinematograph and other projection applications." H. I. Whitty. Dated March 16th.

5,699. "Improvements in storage batteries." A. Pallavicini. Dated March 16th.

5,707. "Improvements in electric fuses for firing, blasting and other explosives." G. Smith and D. Corrie. Dated March 16th.

5,717. "Improved dynamo machine." W. Turvey. Dated March 16th.

5,726. "Improvements in electrical incandescent or glow lamp holders." R. S. Keep. Dated March 16th.

5,734. "Improvements having reference to hydrocarbon engines for driving dynamo-electric machines, and to dynamo-electric machines driven thereby." C. G. Vitali. Dated March 16th.

5,740. "An improved arc electric lamp." D. Loch. Dated March 16th.

5,781. "Improvements in electrolysis and electrolytical apparatus." U. L. P. Le Verrier. Dated March 16th.

5,795. "Improvements in and connected with electric light by incandescence." J. Swinburne. Dated March 17th.

5,797. "Improvements in alternating current induction motors." W. G. Rhodes. Dated March 17th.

5,838. "Elevator and transfer crane for storage batteries." G. H. Condict. Dated March 17th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, September, 3rd, 1898, being date of application in United States.) (*Complete.*)

5,839. "Battery box and tray for motor vehicles." G. H. Condict. Dated March 17th. (Date applied for under Patents, &c., Act., 1883, Sec. 103, September 3rd, 1898, being date of application in United States.) (*Complete.*)

5,840. "System and apparatus for loading and unloading storage batteries." G. H. Condict. Dated March 17th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, October 19th, 1898, being date of application in United States.) (*Complete.*)

5,847. "Improvements in switching apparatus for controlling electric or gas lights for advertising and display purposes." G. C. Fricker. Dated March 17th.

5,849. "Improvements in brushes for dynamos." C. Endruweit. Dated March 17th. (*Complete.*)

5,874. "An improvement in telephones." Siemens Bros. & Co., Limited, and A. S. Schloemer. Dated March 17th.

5,879. "Improvements in incandescence electric lamps." E. Rasch. Dated March 17th.

5,897. "Improvements in telephone holders." E. Pack. Dated March 18th.

5,932. "Improved method and apparatus for rapidly transmitting and recording telegrams." A. Pollak, J. Virag, J. Egger, and F. Silberstein. Dated March 18th. (*Complete.*)

5,934. "Improvements in wave motors or devices for utilising the power of sea waves, more particularly for the generation of electricity." M. Gehre. Dated March 16th.

5,941. "Improvements in incandescent electric lamps." The British Thomson-Houston Co., Ltd. (E. W. Rice, jun., United States.) Dated March 18th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free, 9d. (in stamps).*

1897.

5,805. "Improvements in and in the manufacture of elements for secondary batteries." D. G. Fitz-Gerald. Dated March 4th, 1897. Both the positive and negative plates of secondary batteries are prepared from lead sheets formed by depositing electrolytically upon a thin sheet of lead layers of a more or less crystalline and spongy character. The lead sheets, after being cleaned with alkali, are either roughened mechanically by rollers or by oxidation by exposure to air, or by making the sheet first an anode and then a cathode in a suitable electrolyte. After the electro-deposition of the spongy lead the sheets are passed through water and wound on a drum immersed in water or moisture to prevent heating. From the sheets so prepared elements of required size are cut, and prior to "forming" may be oxidised by exposure to the air. One form of electro-depositing apparatus, in which an endless sheet of thin lead is slowly passed through the electrolyte between the lead anodes by the revolution of the wooden drum, and the lead deposited is consolidated by the spring-pressed rollers, the pressure being gradually diminished as successive layers are deposited. Spring contacts, rubbing on the lead sheet, are connected with the negative terminal of the dynamo, &c. In an alternative arrangement, the lead sheets are sandwiched vertically between a series of anodes and are drawn up successively by a travelling device, which draws them between the consolidating rollers, the process being repeated until the desired number of layers have been deposited. 2 claims.

6,306. "Improvements in jacks for telephone exchanges." Siemens Bros. & Co., Limited. (Siemens & Halske, Germany.) Dated March 10th, 1897. Jacks for telephone switchboards are constructed by taking a tube and removing a longitudinal portion so as to leave a long tongue which is perforated near the end to receive the insulating material moulded around the springs to receive them in position. A row of jacks may be moulded together, or each jack has the insulating material tongued and grooved so that the jacks fit together. In a modified form a screw is used to hold the parts together, the insulating blocks employed being circularly grooved to hold the jacks in position. The tubes are slit to form spring tongues, so that they can be removed from the flared sockets by means of a small tool. 4 claims.